

Research Report 1355

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Job Assessment Software System (JASS) for Analysis of Weapon Systems Personnel Requirements

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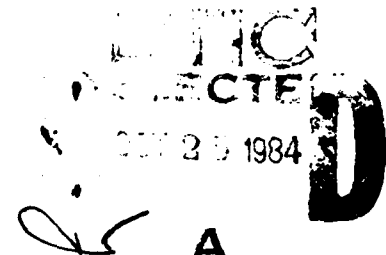


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1980) was programmed onto a minicomputer. The computerized rating scheme, called the Job Assessment Software System (JASS) was designed to allow users to respond to the taxonomy quickly and efficiently. The resulting output is a profile of the aptitude requirements for a weapon systems job. With further development and validation, JASS could be used by military system planners and defense contract system designers to specify the personnel requirements of a new weapons system.

This report describes the initial development and use of JASS. Included are recommendations for further development and testing. Attachment A, Job Assessment Software System (JASS): User's Guide, explains the specific steps to operate and use JASS.



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FOREWORD

Over 600 new Army weapon systems are scheduled to be fielded over the next decade. At the same time the pool of potential soldiers to operate and maintain these systems appears to be decreasing. It is therefore very important to an effective Army that the decisions that are made in the design and fielding of these systems consider the manpower, personnel, and training requirements of the systems. This report describes the concept and initial development of a novel approach toward estimating the human abilities required of Army systems even if they may still be in the design process. The approach takes advantage of the speed and sophistication of modern microcomputers in order to obtain fast and reliable estimates of the human abilities required to perform an Army job or set of tasks. When fully developed the procedure could be a valuable tool in the drive to make soldier considerations a part of the system design process.



EDGAR M. JOHNSON
Technical Director

JOB ASSESSMENT SOFTWARE SYSTEM (JASS) FOR ANALYSIS OF WEAPON SYSTEMS
PERSONNEL REQUIREMENTS: RESEARCH REPORT

EXECUTIVE SUMMARY

Requirements:

In order to integrate the impact of personnel factors into the design of Army weapon systems it is necessary to estimate the human ability or aptitude requirements of the system. This process needs to be accomplished early in the system design cycle. This report describes the initial development of a technique to meet these goals.

Procedure:

Fleishman's taxonomy of 40 cognitive, perceptual, and psychomotor abilities was programmed onto a microcomputer. This computerized version was designed to allow users to respond to the taxonomy quickly and efficiently. The resulting output is a profile of the ability requirements for the particular job that was being analyzed.

Findings:

The ability taxonomy was successfully implemented on the microcomputer and this implementation is described in the report. Further research is needed to test and refine the computerized procedure before it can be used on an operational basis.

JOB ASSESSMENT SOFTWARE SYSTEM (JASS) FOR ANALYSIS OF WEAPON SYSTEMS
PERSONNEL REQUIREMENTS: RESEARCH REPORT

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JOB ASSESSMENT SOFTWARE SYSTEM (JASS) FOR ANALYSIS OF WEAPON SYSTEMS PERSONNEL REQUIREMENTS: RESEARCH REPORT

Background

The Army currently has underway a large-scale modernization program which is expected to result in the fielding of over 600 new weapon systems during the next decade. Historically, the decision to field or not to field a new weapon system has been based on the criteria of hardware cost and performance. Often overlooked was the "human resource cost" of new systems, that is, the number of personnel required to operate and maintain them, and the aptitudes and skills that those personnel must possess. Over the past several years, however, the Army has become acutely aware that the human resource cost of new weapon systems can no longer be ignored (e.g., Kerwin & Blanchard, 1980).

Three factors, operating concurrently, are responsible for this increased awareness. First, census data indicate that the quantity of individuals available for military service (18-25 year olds) will decline throughout this century and, if the birth rate remains unchanged, for the foreseeable future. Second, the aptitudes and skills some new recruits bring into the Army appear to be on the decline. Standardized aptitude and achievement test scores have shown a consistent decline over the past 15 years (Walters, Eitelberg, & Laurence, 1981). Taken together, these two factors indicate increased future competition among the Armed Forces and the civilian sector for qualified personnel. The competition is expected to be the most severe for the more highly skilled individuals.

The third factor is the increasing technological sophistication of the Army's new weapon systems. It is widely accepted that increased sophistication

is increasing operator and maintainer job complexity and, in turn, increasing skill requirements and quantitative demand for personnel (Kerwin & Blanchard, 1980). The Army, therefore, faces the possibility of increasing quantitative and qualitative personnel demands while the capability of the population to fill these demands is decreasing. It follows that the human resource cost must become a factor in acquisition decisions. This, in turn, requires the development of techniques which can provide accurate estimates of manpower and personnel requirements early in the acquisition process. Such techniques will permit comparison of human resource demand to supply and allow the use of human resource data as criteria in weapon system design. Such data could provide the means for making judgments about the impact of design alternatives on the human resource pool, as well as appraisals concerning what constraints the human resource pool may impose on weapon system design alternatives (Askren, 1976).

Problem

Weapon system design begins with a statement of the purpose of the system, that is, one or more "missions" the system is expected to perform. Following the determination of the mission requirements, a conceptual design can be formulated for the new weapon system. Inherent in such a design concept is an allocation of functions between human and machine. Given the specification of the functions to be performed by the human in the system, it is possible to break down those functions into component tasks. The problem at hand is to develop valid techniques that can be used by the system design team to translate these tasks into meaningful behavioral components, and then to obtain a quantitative estimate of the required amount of each component. This information can then be used for comparisons to the human resource supply pool as outlined above. This process is depicted schematically in Figure 1.

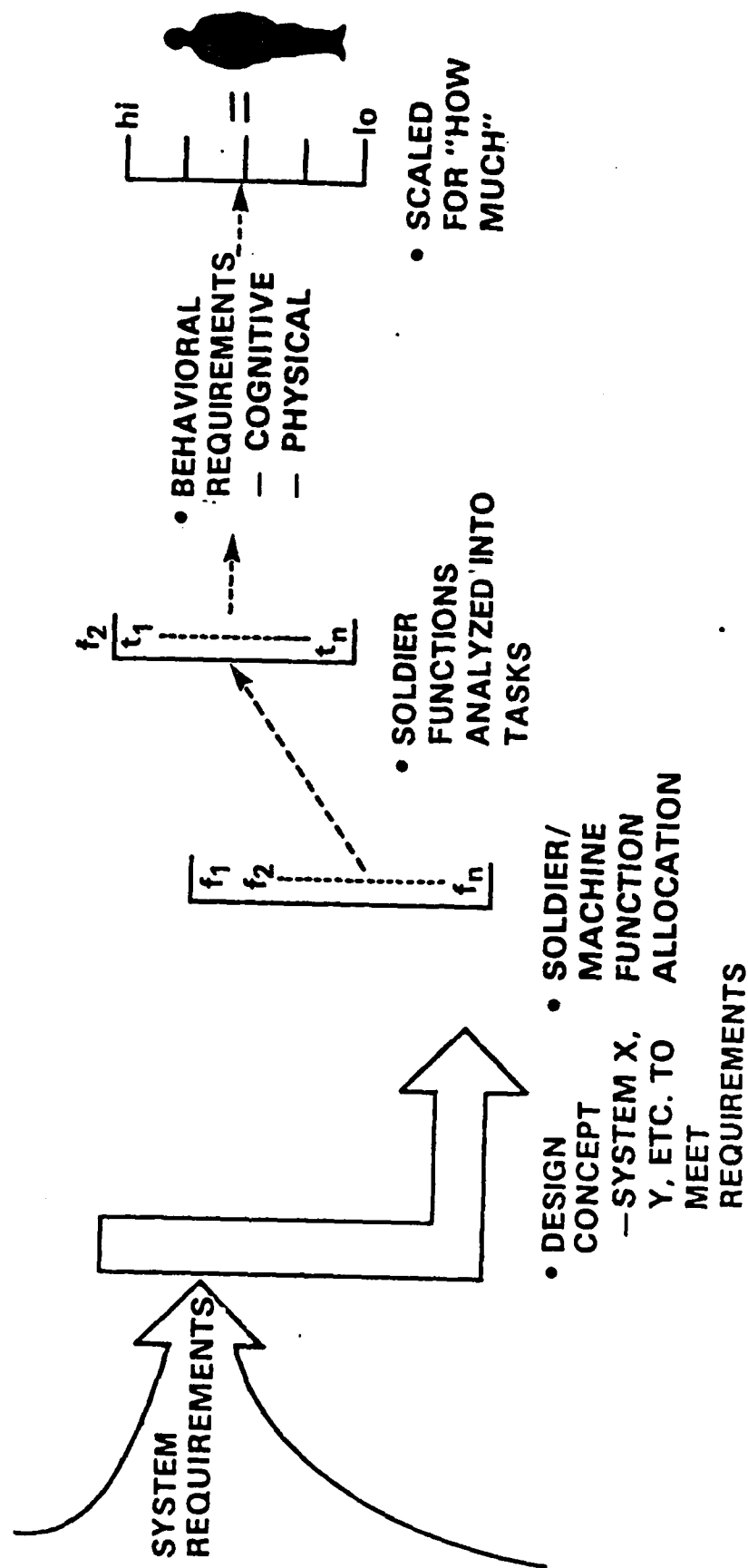


FIGURE 1: Aptitude Assessment Within the Context of System Design

The human aptitude requirement of a system is a key component necessary in making supply-side comparisons. Since the term "aptitude" has several meanings (e.g., Dunnette, 1976, and Fleishman, 1975), it is important to define its use in this context. Aptitude will be used to refer to a general characteristic of an individual that affects task performance. Aptitudes are assumed to be enduring traits that are difficult or impossible to alter through cost-effective training. Consequently, aptitude requirements should be of crucial consideration during weapon system development since any discrepancy between the aptitudes required to operate and maintain a system and those present in the available personnel will be very difficult to overcome.

This report describes the initial development of a structured and time-efficient rating scheme that has potential use for weapon system designers to estimate the human aptitude requirements of weapon systems during the conceptual stage of development.

Basic Approach

The foundation of this rating technique is the extensive research by Fleishman (1972, 1975) who identified basic human aptitudes or abilities and their relationship to performance on a wide range of tasks. This research has resulted in a taxonomy of forty cognitive, perceptual, and psychomotor aptitudes. The perceptual and psychomotor aptitudes in this taxonomy stem from Fleishman's own factor analytic research, while the cognitive aptitudes are taken largely from the Educational Testing Service's manual for factor-referenced cognitive tests (Ekstrom, French, Harman, & Dermen, 1976).

The Fleishman approach was selected over other behavioral taxonomies (i.e., Siegel, 1980) because his basic procedure has been extended (Mallamad, et al., 1980) into a binary decision-flow structure which reduces the information

processing and decision-making demands on the analyst. This structure contains questions and task examples that suggest the presence or absence of an aptitude, and help differentiate a given aptitude from similar aptitudes. The key advantage of this structure is that it lends itself easily to computer implementation. A computerized technique was desirable to provide flexibility, ease of use, and rapid analysis of group and individual data.

Besides the advantages noted above, a computerized approach is able to overcome one of the major problems in using the paper and pencil version of the flow diagrams. Mallamad, et al. (1980) noted that the flow diagrams were useful only in identifying the need for a particular aptitude, and that some other technique is required to determine the level of the aptitude. This determination can be easily accomplished via computer by having "yes" responses to questions in the flow structure lead to an aptitude rating scale like the one shown in Figure 2. This scale (with quantified anchor points, previously established) is used to quantitatively rate the relative level of a particular aptitude required to perform the job or task being analyzed.

This report describes a preliminary computerized job assessment system which uses a standard portable CRT display and off-the-shelf microcomputer components. This system is named the Job Assessment Software System (JASS). The software is modular in format and consists of three basic elements: (1) The binary decision flow branching network for aptitude specification; (2) The capability to produce and display a variety of rating scales and task examples for aptitude rating; (3) Data aggregation, processing, reduction, and analysis routines to summarize system aptitude requirements.

The System Requirements Section describes the development of the software logic system and the preliminary rating scales; the Implementation

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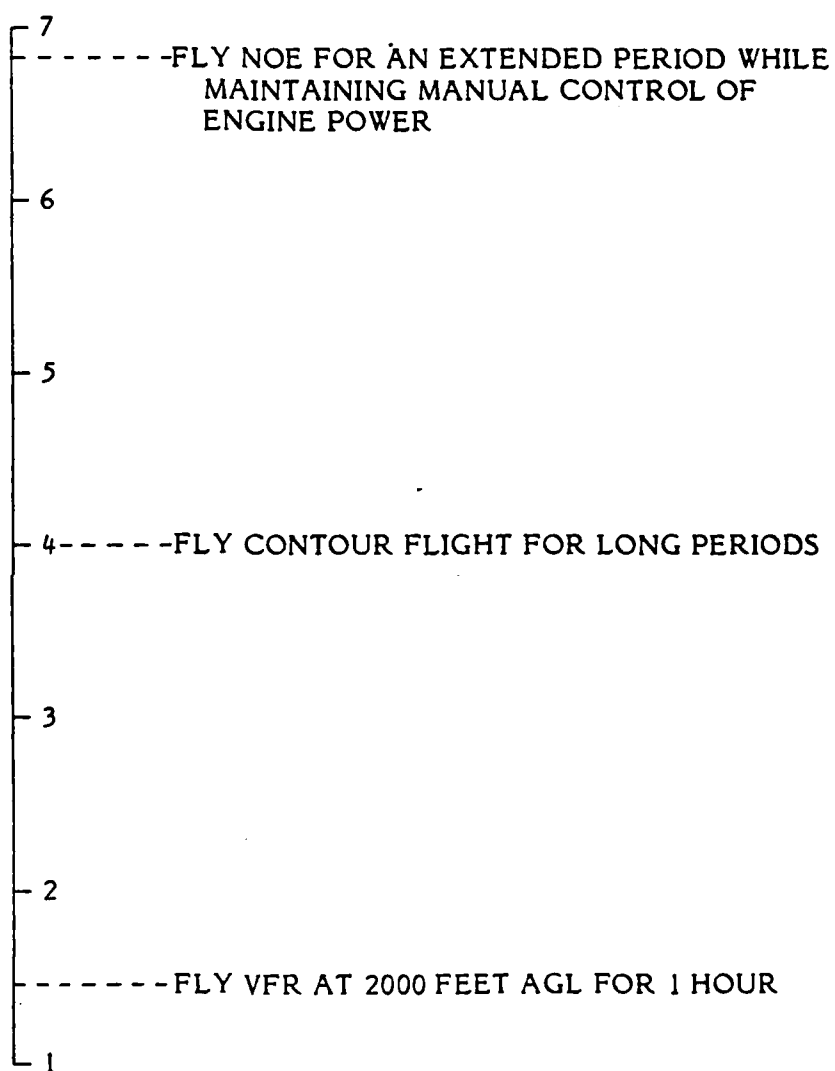


FIGURE 2: Example of Aptitude Rating Scale

Procedures Section summarizes the software and system programs; the Initial User Acceptability Section discusses the initial industry reaction to the system; and the final section, Future Directions, discusses further requirements for research and system refinement.

SYSTEM REQUIREMENTS

The development of the computerized system required two psychological foundations: a workable taxonomy of human aptitudes, and a set of behavioral anchor statements to help quantify the level of an aptitude that is required. Both of these requirements are discussed in turn below.

Aptitude Taxonomy

Fleishman (1972, 1975) identified forty basic human abilities or aptitudes that underlie performance on job tasks. These aptitudes are listed in Table 1.

Table 1: Fleishman's Aptitude Taxonomy

- | | |
|--------------------------|---------------------------|
| ● Oral Comprehension | ● Visualization |
| ● Written Comprehension | ● Static Strength |
| ● Oral Expression | ● Explosive Strength |
| ● Written Expression | ● Dynamic Strength |
| ● Memorization | ● Trunk Strength |
| ● Problem Sensitivity | ● Stamina |
| ● Originality | ● Extent Flexibility |
| ● Inductive Reasoning | ● Dynamic Flexibility |
| ● Category Flexibility | ● Gross Body Equilibrium |
| ● Deductive Reasoning | ● Speed of Limb Movement |
| ● Information Ordering | ● Gross Body Coordination |
| ● Math Reasoning | ● Multi-limb Coordination |
| ● Number Facility | ● Wrist-finger Speed |
| ● Fluency of Ideas | ● Finger Dexterity |
| ● Time Sharing | ● Manual Dexterity |
| ● Flexibility of Closure | ● Arm/Hand Steadiness |
| ● Speed of Closure | ● Control Precision |
| ● Selective Attention | ● Rate Control |
| ● Perceptual Speed | ● Reaction Time |
| ● Spatial Orientation | ● Choice Reaction Time |

Fleishman contends that the combination of these forty aptitudes required to perform a task or job can be used to describe that task or job. Therefore, it

should also be possible to describe the personnel requirements for any weapon system by a combination of the forty abilities.

Mallamad, et al. (1980) extended the utility of this approach by developing a series of binary decisions as to whether or not each of the forty aptitudes is required for performing a job or task. This paradigm was adopted and adapted for the current project. The current JASS branching network consists of transaction blocks and scale blocks. The transaction blocks elicit a "yes" or "no" response from the rater. A "yes" response indicates that an aptitude is required and ultimately leads to a scale block wherein the rater estimates the required magnitude of that aptitude. A "no" response simply jumps the rater to the next aptitude. An example of this process is shown in Figure 3. In the example, the scale blocks are those labeled Dynamic Strength, Trunk Strength, and Stamina. An example of a scale block was shown in Figure 2.

The JASS computer program, written in Applesoft® BASIC language, produces the branching decision network of which the sample in Figure 3 is a part. JASS performs the following functions: formats and displays the text in each of the flowchart blocks, prompts and processes the user responses to the flowchart blocks, sets up a user's file, stores the aptitude assessment scale scores, and retrieves this file if the user revises or appends the job ratings.

The actual text in each of the data blocks is not a part of the computer program. The text is stored on the computer disc as separate text data files. These text data files are "executed" into the program as directed by the user's response. In other words, the main program actually changes as required to incorporate the information in the text data file. For example, if the user answers "no" to a transaction block, the program processes this information and looks for the text data file that follows a "no" response. Each text data file

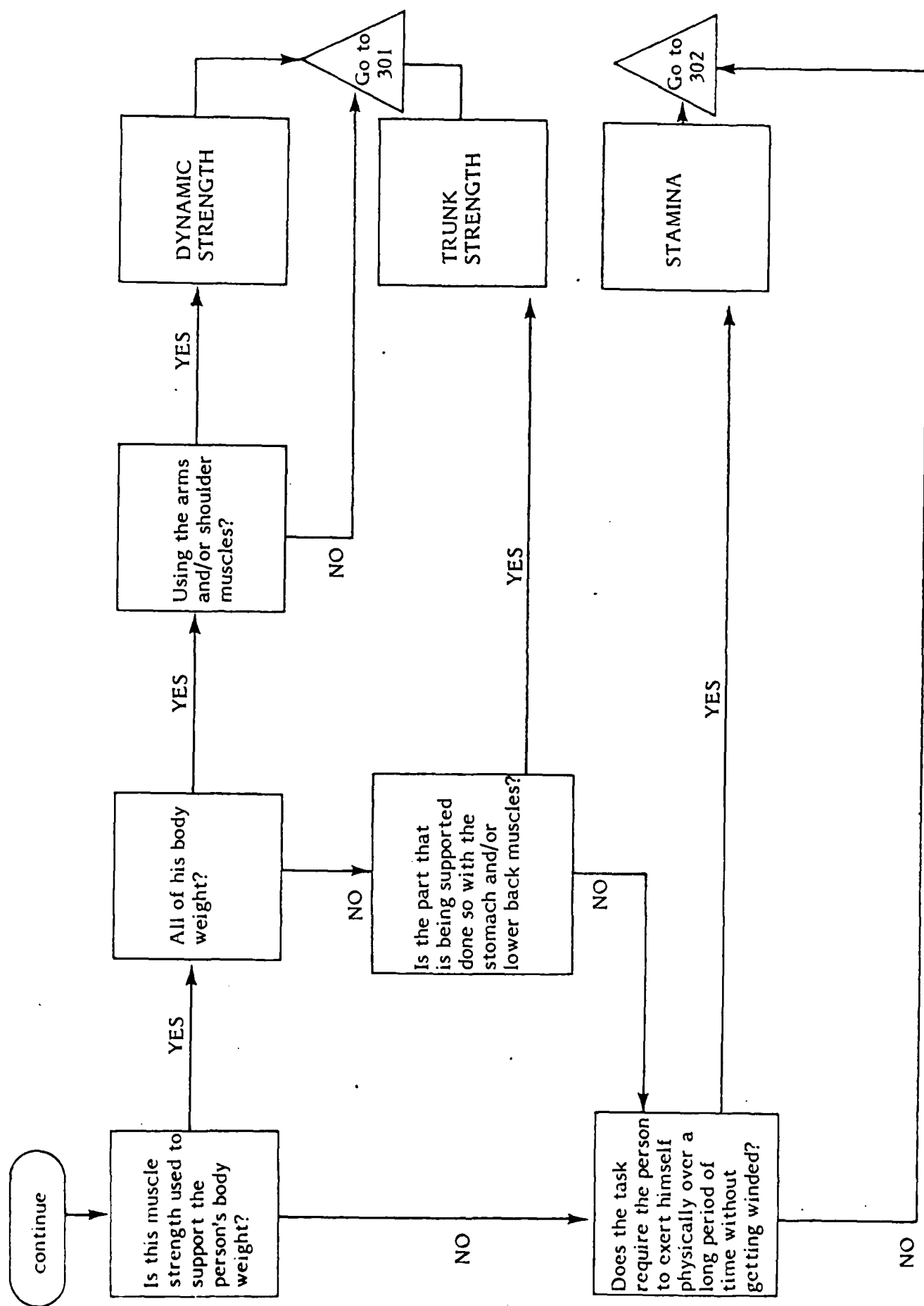


FIGURE 3: Branching Network Decision Flowchart

contains not only the flow block text but the numbers which lead to the next data block. The text data file contains flags which indicate what file is next if the user answers "no" and what file is next if the user answers "yes." In this form, the program can be used with any set of text data files. The branching network program can be used with a variety of test data files without changing the basic program.

Anchor Statement Development

A drawback of the Mallamad, et al. (1980) binary decision flowchart was that by itself it does not produce an estimate of the level of an aptitude required for task performance. The materials developed in JASS combine a branching network decision flowchart with rating scales for each ability. The rating scales allow estimation of the level of each ability needed for a given job. Using these scales, a rater quantifies the required level of an aptitude by assigning a score between 0 and 7. Example task descriptions are placed on the scales to provide the rater with comparisons when rating a specific job. These task descriptions are called "anchor points." In his work Fleishman (1972, 1975) used a set of generalized anchor points (see Figure 4) which are assumed to be applicable to most jobs or tasks. While these scales have been successfully used to evaluate some military jobs (Mallamad, et al., 1980), preliminary studies conducted by the Army Training and Doctrine Command's (TRADOC) Soldier Support Center suggested that they are too general in nature for widespread Army use. For this reason, new anchor points were developed which would be more relevant to the Army environment. Two different sets of scales were proposed: one set designed for a wheeled vehicle repairman and one set designed specifically for a helicopter crewman.

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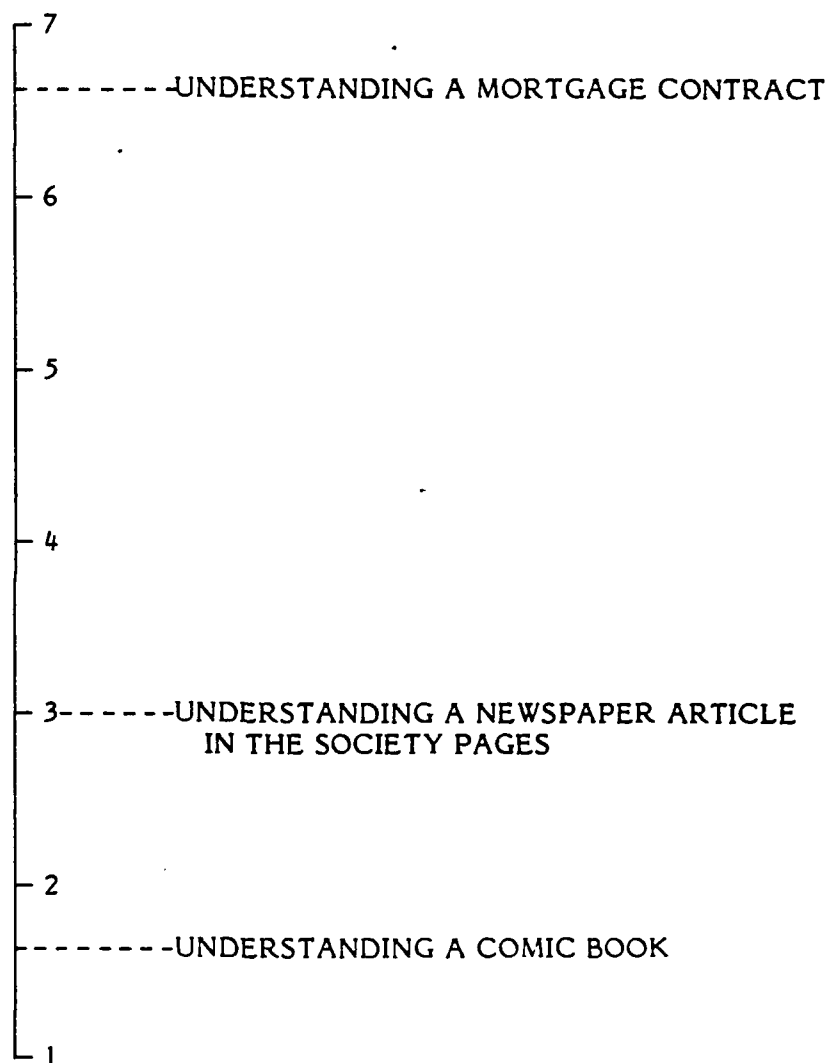


FIGURE 4: An Example of a Generalized Aptitude Scale
(after Fleishman 1975)

The anchor points for mechanic scales were equally spaced on the scale and represent examples of high, moderate, some, and very little aptitude demand levels. This scale is a graphic rating scale which allows the rater to indicate the degree of the aptitude required by the task. It is the simplest and most common type of rating scale. An example mechanic's scale is shown in Figure 5.

The job-relevant anchor points were added to the mechanic scales through a structured, although subjective, procedure. The job of mechanic was selected as an example for initial program development because the developers were somewhat familiar with the job requirements. A determination was then made of the variable factors in the activity which defined the degree of difficulty. The authors of the anchor points first tried to identify an activity associated with each ability which could be put on a continuous scale of difficulty. The range of activity difficulty was divided into three equal parts, using example tasks representing four difficulty levels: high amount, moderate amount, some, very little. Example tasks were drawn from the authors' experience.

However, the authors were not sufficiently experienced mechanics to be able to develop meaningful job examples for all aptitudes. This points out the problem of this approach to anchor development. As pointed out earlier, preliminary studies indicated the desirability of job-relevant anchor points. The mechanic's scale anchor points were developed on the basis of factors inherent in the aptitude itself. Job relevant examples were added when possible. If one, two, or three authors had prepared the anchors purely from the basis of job related tasks, personal biases would have undoubtedly affected the results. Clearly, job specific anchor points should be prepared by a statistically significant consensus of subject matter experts. Because of these shortcomings, the current mechanics scales are usable only as place holders during the software

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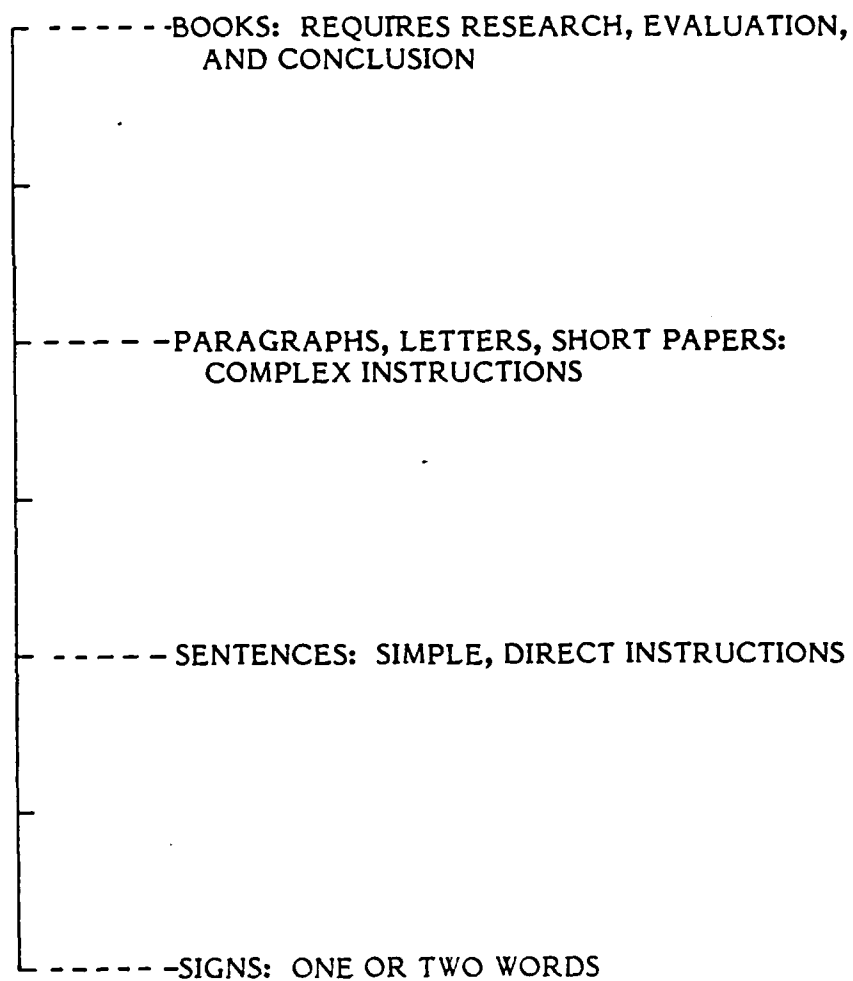


FIGURE 5: Sample Mechanic Aptitude Rating Scale

development and for some preliminary testing. New scales are needed for operational use.

In his work, Fleishman uses a set of generalized anchor statements which are assumed to be relevant across all or most jobs and tasks. Such generalized anchors have two major advantages. First, they are based upon considerable research with large sample sizes, so they should be accurate and stable; second, use of generalized scales should allow simple and straightforward comparisons of aptitude requirements across Army systems. The generalized scales may present a serious disadvantage, however. In an unpublished work, the Soldier Support Center (SSC) used generalized aptitude ratings in a survey format as part of the Soldier Machine Interface Requirements (SMIR) study advisory group's investigation. This research was terminated before completion and subjected to considerable criticism. The basis of this criticism was the belief that the general anchor statements were not relevant to Army jobs and would be difficult for Army personnel to understand. While the basic issue of general versus specific anchors can only be resolved with further research, it was decided that the initial testing of the JASS procedure should use anchor statements that are directly relevant to an Army job. It was believed that this decision would increase the Army's acceptance of the procedure. The job chosen for analysis was that of a helicopter crewman.

The anchor points for the helicopter crewman's scales were adapted from the aptitude scales used by Rossmeissl and Dohme (1982). The scales in this study were based upon a modified list of Fleishman's (1975) aptitudes (see Appendix B for definitions of the aptitudes that were used). The scaling technique utilized was similar to that which is used to develop behaviorally

anchored descriptions of job behavior (Smith & Kendall, 1963) or weighted behavioral checklists (Knauft, 1948).

Four Army helicopter missions (aeroscout, attack, cargo, and utility) were studied to determine the abilities that underlie successful mission performance. Thirty aptitudes were identified as possible requirements in the task analysis of the four missions. To develop aviation-specific anchors for these 30 aptitudes, an ARI psychologist and an ARI Master Aviator developed as many Army aviation task statements as possible for each aptitude, the objective being to create anchor statements that would cover as much as possible the range of each aptitude from the least to the greatest level required for performing all four Army aviation missions. In other words, mission general statements were developed that were common to all four missions. For each aptitude, fifteen to twenty candidate anchor statements were generated using the Aircrew Training Manuals and Helicopter Operator's Manuals (Dash Tens) as guides.

Once the candidate anchor statements were generated, two Standardization Instructor Pilots (SIPs) were brought in to represent each mission and a roundtable discussion was held to eliminate those statements that were judged not to apply to all four missions. Certain mission oriented statements were also eliminated because they are not part of the training regimen for a given mission. In addition, the eight SIPs edited the wording of the statements to improve their clarity. This process reduced the number of anchor candidates down to 288.

The remaining anchor statements were included in an evaluation package that was administered to 44 field experienced Army Warrant Officer aviators. These subjects comprised 31 current field aviators from Fort Hood and 13 students in the Warrant Officer Senior Course at Fort Rucker. The subjects, who

were mostly CW3 and CW4 ranks, were distributed across the four missions as follows: aeroscout 20%, attack 27%, utility 23%, and cargo 30%.

The specific rating procedure was adapted from the methodology developed by Fleishman (1975). The subjects assigned a value from 1-7 to each statement corresponding to the amount of the given aptitude required to perform the aviation mission. Conceptual definitions were provided for each aptitude. The mean and standard deviation for each of the 288 candidate statements were calculated and an attempt was made to select three anchors for each aptitude: one high, one low, and one medium. In a few cases (6 of the 30 abilities) it was not possible to develop three anchors because the mean values clustered toward one end of the seven point scale, so only two anchors were created. For each aptitude, the criterion was to select anchors that had small standard deviations, preferably 1.5 or less. The anchors were selected to obtain the highest and lowest mean ratings having small standard deviations and also the rating closest to midscale (3.5) having a small standard deviation. An example of these scales is shown in Figure 6. Rossmeissl and Dohme (1982) found that these scales successfully discriminate among the aptitudes required to operate the new aeroscout helicopter and showed reasonable inter-rater reliability.

The JASS system can be used in this procedure to develop meaningful, job-specific anchor points. The computer is used to implement the methodology used by Rossmeissl and Dohme (1982), with a combination of traditional and modified Fleishman (1975) procedures to obtain anchor points. Six to ten job task examples are prepared for each aptitude. Subject matter experts rate each task example for the amount of aptitude required. The ratings are made in this case using the computer video screen and keyboard. Data can then be saved and analyzed by the computer. Tasks are selected as anchor points based on the

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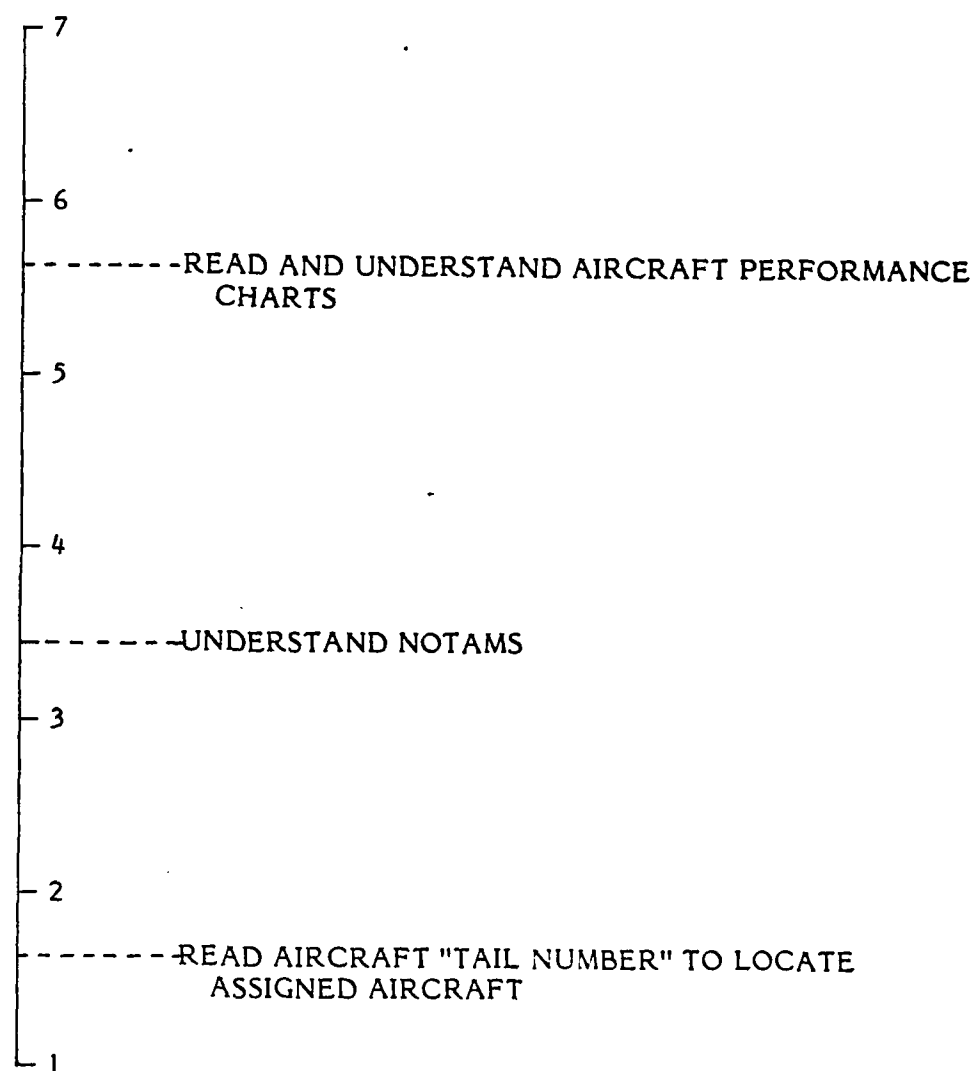


FIGURE 6: Sample Helicopter Crewman Aptitude Rating Scale

consensus of the raters, with low variability tasks being the anchor points of choice. At the present time, two sets of example tasks have been developed and entered into JASS: mechanic and mechanized infantry vehicle crewman. These tasks can now be rated by subject matter experts knowledgeable in each of these two jobs. The results will provide objective anchor points for the jobs of mechanic and mechanized infantry vehicle crewman.

IMPLEMENTATION PROCEDURES

Software System Overview

This chapter briefly summarizes the current systems capabilities and operational procedures.

JASS is designed for use by weapon systems developers, i.e., human factors analysts, design engineers, the integrated logistics support group, and military system planners. The software contains programs which develop scaling anchors, collect job assessment data using the scaling anchors, and provide summary statistics from several people assessing a job.

Use of JASS requires the following equipment: an Apple® II Computer, monitor, two disc drive units, and the JASS discs.

The following is a brief description of the programs that make up JASS. A full description is contained in the user's manual (Attachment A).

1. Job Assessment -

This program allows the user to select and rate the aptitudes required to perform the job. The program follows a branching flowchart as shown in Figure 3. The user can either use the game paddles or keyboard to interface with the computer. The user can quit at any point and come back later and pick up where he left off. Several users can save their file with a

common job name and average job rating scores can be tallied and displayed.

2. Job Assessment Review, By Rater -

This program allows an individual to review his job rating file. The aptitudes selected are displayed in order of the degree required to perform the job. The aptitudes which are not selected as being requirements for the job are also displayed.

3. Job Assessment Review, Tally -

This program presents the summary statistics of a group (up to 40) of people rating the same job. Aptitudes are ranked and displayed according to their average scores. Mean score, number of subjects rating the aptitude, and standard deviations can also be displayed on request.

4. Job Assessment Revision -

This program allows the individual rater to change or update any aptitude rating without having to repeat the entire job assessment program.

5. Anchor Point Development -

This program provides a research tool for developing meaningful anchor points for scaling aptitudes. A subject matter expert is first presented with an aptitude definition and is then asked to score a series (approximately 8) of job tasks for the degree of the aptitude required. These job tasks are generated by individuals familiar with the job. They are presented as examples of tasks which require the aptitude. The computer accumulates the scores of each subject. The rater can "skip"

the task if he or she does not understand it or feels that the aptitude is not required to perform it. "Skips" are also recorded.

6. Anchor Point Development Scores -

This program is used with the anchor point development program and allows the user to review the rating statistics for any one of the aptitude anchor point tasks. Statistics presented are: number of subjects rating the task, sum of the rating scores, sum of the rating scores squared, sum of the squared rating scores, and the number of "skip" responses.

A user's guide has been developed for the administrator of JASS (see Appendix A). The guide describes JASS characteristics and requirements, the Apple reference documentation, disc care and handling, the software system, the file structure, and the current career field packages. It also includes a chart showing the JASS programs and their interrelationships, a reference sheet summarizing the use of the JASS programs, and an appendix with instructions for the "WRITE," FWRITE," and "SWRITE" programs. These latter three programs prepare the text for the job assessment and anchor point development programs.

INITIAL USER ACCEPTABILITY

Preliminary views on user acceptance of the JASS procedure were obtained at FMC Corporation, San Jose, California (largest producer of military tracked vehicles) and Northrop Corporation, Anaheim, California (producer of sensor units for the OH-58D Helicopter). Based on these preliminary on-site observations at FMC and Northrop, user acceptance of the JASS is good. ARI and MGA personnel visited these sites to meet with potential JASS users from the human factors, logistics, training, and design engineering groups. First, a presentation

of the overall aptitude/task tradeoff procedures that occur during any Army system development program was conducted. This presentation began with the identification of the need for a technique by which system designers can estimate aptitude requirements of operational and maintenance personnel. The presentation then traced the aptitude/task trade off process, identifying the employment of job assessment techniques. Next, JASS was demonstrated. Finally, comments from FMC and Northrop personnel were solicited.

Both contractors saw the utility for the JASS. They agreed that it would serve as means of communication between the Army and system designers. In addition, they felt that it would serve as an excellent in-house communication tool. Hardware design engineers, human factors and training psychologists, and integrated logistics support technicians all have different definitions of human abilities. For example, a maintenance engineer, human factors analyst, and design engineer may all look at the same electrical installation drawing but will each draw different conclusions concerning task (and therefore aptitude) requirements. The human factors analyst may worry that a person wearing Arctic mittens will not be able to repair it; the maintenance engineer may be concerned with the mean time to repair it; the design engineer may be concerned with manufacturing tolerance and electrical interference. If all agree on a common term for the problem (say, high demand for manual dexterity), it will help to identify and eventually correct the problem. JASS can assist in making design trade-off decisions based on a framework of common human resource demand definitions.

FMC and Northrop personnel did express concern, however, about the validity and comprehensiveness of the 40 psychologically defined aptitudes. Could the requirements of a job, such as an electrician, be accurately defined in

terms of these 40 aptitudes, and once the job is defined, could the Army personnel be identified and selected to meet these requirements? ARI/MGA personnel explained that the scales had already been used and found adequate to describe some military jobs. Further testing is needed to ensure reasonable coverage of the full range of military jobs. In addition, it was explained that the computer itself could be programmed to "learn" job aptitude demands and assist in the definition of new jobs. The Army and ARI are developing programs whereby military personnel can be tested and categorized according to the aptitudes. The goal is a common definition for personnel resources and job aptitude requirements. Some hardware-oriented engineering personnel distrust psychological definitions and theories. JASS overcomes this problem to some extent because the aptitudes are self defining in non-psychological terms when one follows the branching network flow. Psychologically-based definitions become invisible to the user.

FUTURE DIRECTIONS

General

The basic problems concerning development of a computerized job assessment system have been resolved. The branching network job assessment flowchart was implemented in software. This software is packaged to enable a user to understand and successfully operate the computer system with minimal direction. There are several issues to be resolved and capabilities to expand before a final job assessment software package is produced. These issues tend to fall into two groups: those requiring further psychological research and those requiring modifications to the system software.

User Acceptance

User acceptance is of primary importance. Validity testing or any program improvements will not be possible unless the user understands and feels comfortable using the software system. JASS must be human engineered to meet the capabilities and limitations of a potentially wide range of users. Human engineering and user acceptance testing have already been done in a very informal manner at the developers' facilities (see Initial User Acceptability Section). Further testing at FMC and Northrop Corporations should provide a broad enough user data base upon which some programming improvements can be made.

Both FMC and Northrop were extremely interested in participating in pilot studies. Each company proposed that a small group of their engineers rate jobs on systems currently under development within the company. The engineers would be selected from a variety of disciplines: human factors, logistics, training, and hardware design. Northrop proposed that they rate the job of maintaining the mast mounted sight for the OH-58D Helicopter. FMC proposed several alternative hardware items including the DSWS vehicle. The information to be obtained from these studies would include:

- A comparative analysis across raters which would give some indication of the model validity.
- A critique of the task examples and the anchor points in terms of their applicability and meaningfulness.
- An analysis of JASS results compared with the results of other currently employed job assessment techniques (i.e., human factors summaries, QQPRI, ILS worksheets, etc.)
- Subjective comments and suggestions from test subjects regarding system usability.

Anchor Point Specificity

Aptitude scale anchor points could range in scope from universal (applicable to any job) to very specific (applicable to and understood by only one occupational specialty). Ideally, there exists a single set of anchor points against which to weigh any job ability requirements. This, however, will rarely occur. Tradeoffs must be made between the cost of specificity and the amount of information which is sufficient to describe the aptitude requirements of a weapon system. Anchor point specificity can be addressed through both usability and validity testing. The present anchor point development program has a "skip" option which may be exercised when the user feels the task is not appropriate as an anchor point. This same mechanism could be built into the job assessment software. The user could be asked to rate the anchor points in addition to rating the job itself. In addition, levels of specificity could be established and anchor points developed for each level. A test would then be conducted in which subjects rated the same job using the various sets of test anchor points. Comparative analyses of user response and job rating results will assist in determining the information gained by increasing specificity.

Validity of the JASS Procedure

There are two principal types of validity analysis that are relevant to JASS. Content validity is established through a logical analysis of the measurement tool to determine whether it measures those principles it is supposed to measure. A refined JASS should be inherently high in content validity since it will be based upon a careful analysis of human aptitude, assessment procedures, and the system design process. An additional check on the content validity of JASS could be obtained by comparing the results of JASS to the results of more traditional job analysis techniques; i.e., QQPRI, task analysis summaries, mainte-

nance allocation, etc. This method would have the advantage that the research could be conducted during the development of an actual weapon system (i.e., DSWS). The other method of validation that should be investigated for JASS is criterion validity. Criterion validity through correlation analyses predicts the degree to which some measurement will predict a specified criterion. In the case of JASS, this criterion would be the actual aptitude required to operate or maintain a fielded system. One form of criterion validity testing that could be done with JASS would be historical in nature. One could take an existing Army system (i.e., M109) and have members of a design team who are familiar with the system rate its aptitude requirements using JASS. These ratings could then be correlated with measures of the aptitudes of individuals successfully operating and maintaining the fielded system. This procedure would provide a direct comparison between predicted and actual aptitudes and would be the best measure of JASS' criterion validity. However, it would also be quite demanding in terms of time and troop support. A more economical index of criterion validity would involve system designers and Army subject matter experts both using JASS to analyze the aptitude requirements imposed by the same piece of hardware. This analysis would reveal how well the estimates of human aptitude requirements made by the system design community will match those made by Army personnel who are familiar with the actual field operation and maintenance of the system.

Program Efficiency

The current software programs are written in the BASIC programming language. While BASIC has the advantage of widespread use in micro-computer systems, it is difficult to modify and expensive to document. BASIC programs are inherently slow and the user must frequently wait some time for the program

to proceed. Consideration should be given to programming the system in PASCAL. This would simplify program revision and expansion and, therefore, the programs will run faster and more efficiently. BASIC programming language is written in linear format. The program itself does not operate linearly, however. Branching subroutines and loops are all hidden within sequentially numbered lines. PASCAL, on the other hand, is written and operates in a functional format. Functions, variables, and constants are all predefined and grouped in a straightforward easy-to-read format. Program revisions necessary as a result of user testing will be more easily and quickly accomplished in PASCAL.

Increased Computer Capability

At its present stage of development, JASS provides a neat, compact, and easy-to-use job assessment tool. Current computer technology, however, has the potential to provide a much more powerful tool. For example, mini-computers have considerable more storage capacity than is currently used for JASS. There are several potential sets of job aptitude rating scales, each applicable to a different career field (only mechanic and helicopter pilot exist now). The computer would determine the appropriate set of scales for a particular job assessment through a set of introductory questions. An introductory program would explain the use of the system and, through a series of questions, identify the scale set most appropriate to the job.

Artificial Intelligence

Current programming capabilities make it possible to have a software system that "learns" from the user as well as one that allowed the present user to learn from the responses of previous users. Such a system would select questions and negotiate responses with the user using the responses of previous

users as the basis of negotiation. The programming techniques used to accomplish this capability are called Artificial Intelligence (AI). The following is a brief example of how this might work:

The system, as it is currently envisioned, would be menu driven to elicit information about the boundary conditions of the job being assessed. The highest order menu would contain global job titles such as: mechanic, baker, teacher, pilot, etc. and ask the user to select the job most like the one being assessed. If the user selected "1. Mechanic," the next menu would present more specific information about mechanics such as: automotive mechanic, tracked vehicle mechanic, fixed wing reciprocating engine mechanic, rotary wing reciprocating engine mechanic, etc., and ask the user to select that job closest to the job being assessed.

The final menu in this sequence could ask the user to select that system most closely resembling that in which the job incumbent will be working. For example, if the user has selected tracked vehicle mechanic, he or she would be presented with a menu including systems in this area. An example menu is: M113 APC, M60A1 Battle Tank, IFV, M1 Main Battle Tank, etc.

A final selection at this level would initialize the scales and data matrices with the boundary conditions for a mechanic in this weapon system. The user would then proceed through the branching scales "teaching" the software how the new system requirements differ from the old system. The user would be given the opportunity to branch around inappropriate scales as in the current JASS. However, if the rater skips a scale which had been rated in the old

system, the software would switch into negotiation mode and seek to determine what accounts for the system differences. This would also occur when the user rated a scale especially high or low in comparison with that scale's rating on the old system.

The development of this software would seem at first glance to require a tremendous amount of tedious textual input which would be difficult to manage and produce. This is overcome by the nature of AI software. AI software is constructed within the framework of a work breakdown structure in which the individual functions, procedures programs, and utility programs are all specified in a formative (front end) analysis. The central features of this analysis are twofold:

1. The individual blocks of the system each perform a single and non-redundant function. Block control is always passed off to the executive program which is kept at the simplest level of function, i.e., it does not input information, compute outcomes, or output information; it simply directs the execution of these operations.
2. The system learns, beginning in an unbounded state. As users input increasing system level information, the AI software continues to reduce uncertainty about new systems as well as systems previously entered.

The current software system will have to be designed and/or programmed (e.g., in PASCAL) to produce the AI capabilities.

Summary and Conclusions

This report has described the development of a computerized job assessment system which provides a profile of the personnel aptitudes required to operate a weapon system. The system, called JASS, provides a convenient, easy-to-use method for designers and developers to describe the human resources demanded of a weapon system. Preliminary testing of JASS was described and future needs discussed. The recommended modifications to JASS are expected to:

- Improve user acceptance
- Improve validity and reliability
- Improve programming efficiency
- Determine most appropriate types of anchor points
- Develop capability for software to "learn" about weapon systems through accumulated user input.

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ATTACHMENT A

USER'S GUIDE

JOB ASSESSMENT SOFTWARE SYSTEM (JASS): USER'S GUIDE

SCOPE

The Job Assessment Software System (JASS) is a set of tools which allows collection of job assessment data using a microcomputer. These job collection data fall into two categories:

1. Data for development of scale anchor points.
2. Job assessment data collected from subject matter experts using the resultant scale anchor points.

This guide has been prepared for those users who will be responsible for managing the data collection for both the development of behavioral scale anchor points and job assessment. The programs used by job assessment subject matter experts have been designed to be free standing and self instructional.

SYSTEM CHARACTERISTICS AND REQUIREMENTS

JASS is contained on 5 $\frac{1}{4}$ inch floppy discs. The system requires the following hardware:

- Apple II[®] microcomputer with 48K memory.
- Video monitor (40 column, color or non color)
- Two Apple[®] disc drives with disc controller mounted in slot #6.
- Apple DOS 3.3[©] disc operating system

Optional hardware includes 64K memory expansion and the Apple® game paddles. All of the programs are written in Applesoft® Basic, and the system is menu oriented under turnkey operation. This means that the system is "booted" (placed in use) in the normal manner.

APPLE® REFERENCE DOCUMENTATION

If you are unfamiliar with the Apple® microcomputer system, we recommend that you read, as a minimum, Chapters 1 through 4, and Appendices G and J of Apple II, The DOS Manual. The programming language documentation is contained in APPLESOFT II, THE BASIC PROGRAMMING REFERENCE MANUAL. It is not necessary to become an expert programmer in order to use JASS; however, a familiarity with these reference manuals may be helpful to you.

DISC CARE AND HANDLING

Floppy discs are made of a magnetic recording material that is mounted in a permanently sealed square cover. DO NOT OPEN THIS PACKAGE. This will destroy the disc. While the discs are called "Floppies," they can actually be destroyed by bending. The following DOs and DON'Ts should be routinely practiced.

DO—

Handle discs gently.

Store discs in the paper envelope supplied with the disc.

Store discs vertically in a cool location.

Back up (copy) your discs routinely.

DON'T—

Write on the disc label with a ball point pen or other sharp writing instrument.

Store the discs where you suspect magnetic field, i.e., on the top of the disc drive or video monitor, or near permanent magnets.

While the definitive answer is not known, the present authors do not carry discs through magnetometer inspection stations at airports. We have not lost one yet!

CAUTION

NEVER remove a disc while the drive's "IN USE" light is on. This may permanently damage the disc, and is almost sure to destroy the information on it. In such a case, the disc can usually be re-used, but you won't be able to recover the lost information.

BACKING UP THE SYSTEM DISCS

As you have gathered from the previous section, accidents can happen and discs can "crash." Now is a good time to back up your program to insure its safety. You should establish a firm practice of backing up discs when you are collecting data to insure against data loss. Copying the discs can be readily accomplished in two ways: by using the COPYA program, or the FID program which are stored in your Apple® System Master Disc. To use COPYA, follow the instructions on page 38ff of the DOS Manual. To use FID, refer to page 184ff of the manual. These programs have slightly different characteristics, and you should familiarize yourself with them before attempting to copy your discs.

SOFTWARE SYSTEM OVERVIEW

The software contains programs which develop scaling anchors, collect job

assessment data using the scaling anchors, and provide summary statistics from several people assessing a job.

JASS is divided into career field packages. The task examples in each package are devoted to a specific career field (i.e., automotive mechanic, electrician, pilot, etc.). Two career field packages have been developed to date: automotive mechanic and helicopter crewman. In addition to a difference in the task examples, there is a slight difference in the programming between these two packages. The anchor points in the job assessment portion of the automotive mechanic package have not yet been scaled and are, therefore, at four equally spaced points on the scale (high, moderate, some, very little). The anchor points in the helicopter package have been scaled and, therefore, vary with each scale. The programs (FABD2 and FABD2P) are slightly different to handle this variability in anchor point location. Flexible anchor point location also created a need for "FWRITE," the program to write and edit these flexible anchor points. (All programs beginning with "F" e.g., "FWRITE," "FABD2P," etc., are designed to handle the flexible anchor points.)

The automotive mechanic disc package consists of the following:

- User's Disc - Mechanic

Contains the majority of system programs. Also stores the job assessment data (stored as a text file under a user-selected name) and anchor point development data (stored as text files under the name SCATA XXXX, where XXXX is the scale number).

- Disc A-Mechanic, Side 1 and Side 2

Contains mechanic job assessment transaction and scale data block text files under the name DATA XXXX (where XXX is the number of the block). Also contains WRITE, a program used to write the data block text files.

- Disc B-Mechanic

Contains automotive mechanic anchor point development program text files under the name of SC XXXX (where XXXX is the number of the scale). Also contains SWRITE, a program used to write the anchor point program text files.

The programs contained in the JASS Mechanic's discs are functionally shown in Figure 1. The utility programs provide the computer graphics as the means of writing and editing the text files.

The helicopter crewman disc package consists of the following:

- User's Disc-Helicopter Crewman

Contains a majority of the system programs. Also stores the data for the job assessment data (stored as text files under a user-selected name).

- Disc A-Helicopter Crewman, Side 1 and Side 2

Contains the helicopter job assessment transaction and scale data block text files under the name DATA XXXX. Also contains FWRITE, a program used to write the data block text files.

Disc B - Helicopter Crewman is still in development. The programs contained in JASS Helicopter Crewman's discs are functionally shown in Figure 2.

In addition to the mechanic and helicopter crewman disc packages, a mechanized infantryman disc package has been started. The package presently has just one disc:

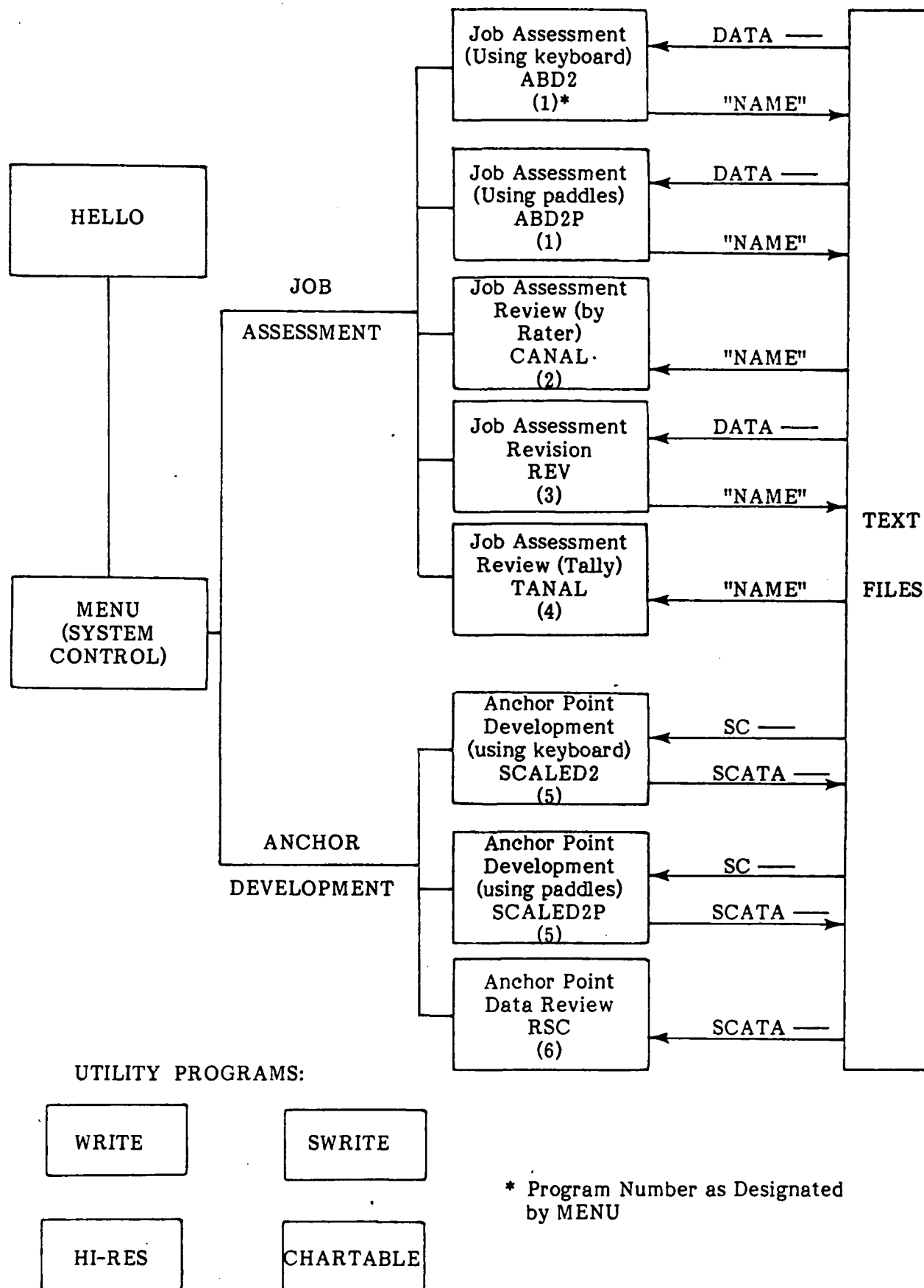
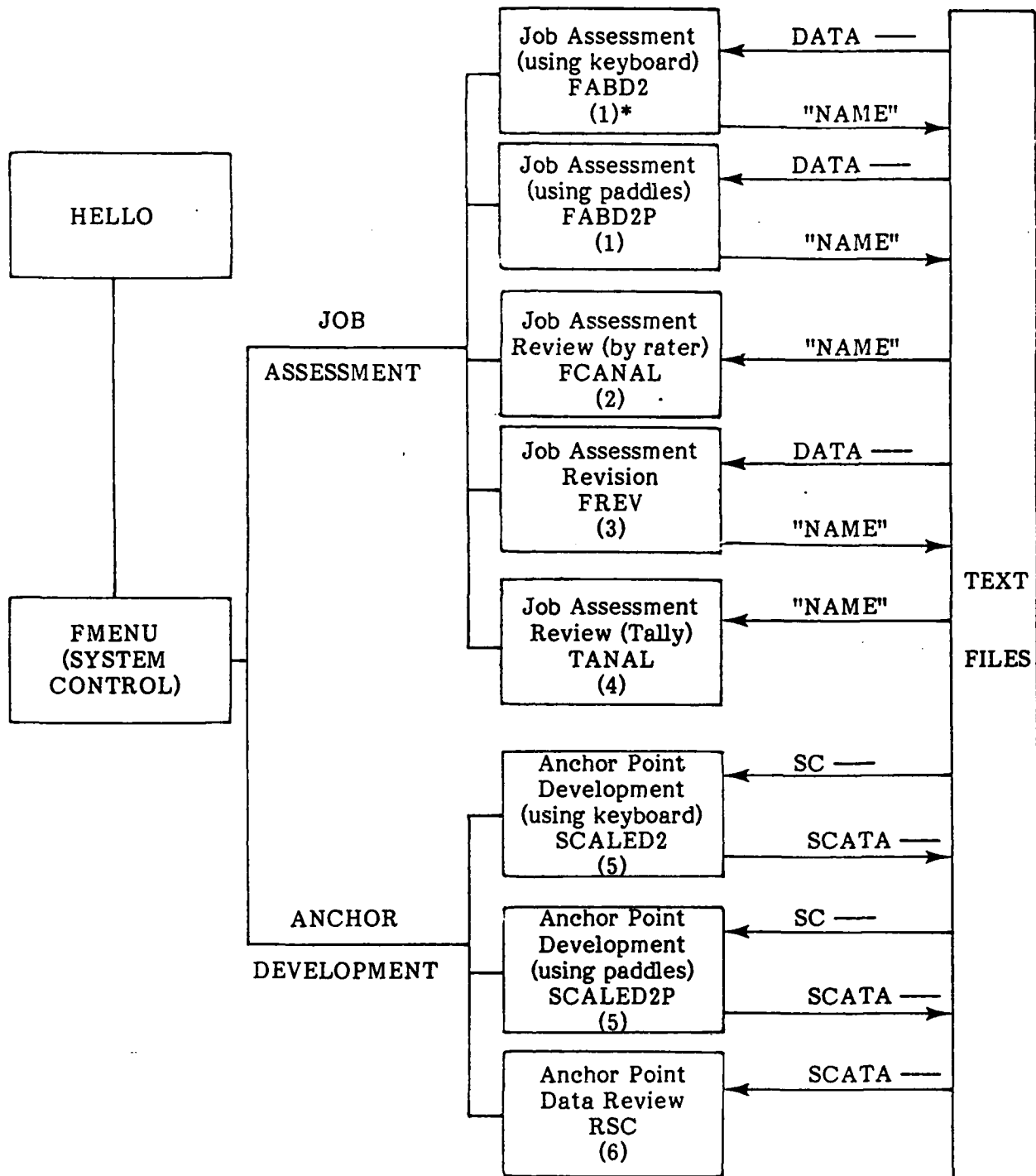


FIGURE 1: JOB ASSESSMENT SOFTWARE SYSTEM (JASS) - MECHANIC
(PERMANENT ANCHOR POINTS)



UTILITY PROGRAMS:

FWRITE

SWRITE

HI-RES

CHARTABLE

* Program Number as Designated by MENU

FIGURE 2: JOB ASSESSMENT SOFTWARE SYSTEM (JASS) - HELICOPTER CREWMAN (FLEXIBLE ANCHOR POINTS)

- Disc B - Mechanized Infantryman

Contains mechanized infantryman anchor point development program test files. This disc can be used with the User's Disc - Mechanic. Caution must be taken, however. Do not use the same mechanic User's Disc to collect both mechanic and mechanized infantryman anchor data. One set of data will overwrite the other. Use two separate mechanic user's discs to collect this data.

The next section of this guide describes the software system's individual components. This section is written in hands-on interactive form and proceeds quite rapidly. The best way to learn what each component of the system does is by actually setting up your own job to analyze, and then using each of the system's components to perform the analysis. We have tried to make each program self-explanatory and self-corrective. If you have problems or criticisms, we would appreciate it if you would tell us.

SYSTEM OPERATION

When the User's Disc is booted, the HELLO program brings up Applesoft Basic, installs the high resolution character generator utilities, and runs the system controller program MENU (or FMENU). MENU presents the various options to the user and passes control to the appropriate transaction program based upon the user's response. When the transaction is completed, that program passes control back to MENU for the next option.

Boot the User's Disc and read the MENU. Press key 1 to assess a job and read the information presented. Press "Y" to continue, and MENU asks whether you want to use the game paddles or the keyboard to enter information. Depending on the response, MENU will "RUN" either ABD2 (or FABD2) — keyboard response, or ABD2P (or FABD2P) — game paddle responses. Both of these programs implement the branching scales network for job assessment. Run

through a portion of the Job Assessment program, and then exercise the quit option. Save your responses under your name and when you return to MENU, select option 2, Review Job Assessment (by Rater).

MENU passes control to the program CANAL (or FCANAL) which presents you with a simple graphic review of your ratings from highest to lowest. Also, you will see the list of those skills not selected. Exercise quit option and return to MENU.

Now select option 3, Revise Job Assessment. The first part of the REV (or FREV) program is identical to CANAL except that a pointer appears to the left of the list of skills. Move the cursor so that it points to a skill rating you want to change, then press the "RETURN" key. You will then begin the job assessment program (ABD2 or FABD2) at the specific point which skill rating can be changed. All skill ratings made will supercede any previously made ratings. Change the skill rating and go back to the MENU.

Job Assessment Tally (TANAL or FTALLY), MENU option 4, is again the same as the CANAL program, except that the skill ratings shown are the averages for several users (up to 40). The program also computes the standard deviation of each of the ratings. Press the S(tatistics) key and the screen will display the number of subjects selecting an aptitude scale, the mean scale score, and the standard deviation. Mean and standard deviation scores are based on a scale from 0 to 7. If a subject "branches around" an aptitude scale, the scale is scored a zero.

As with the Job Assessment programs, there are two scale rating programs, SCALED2 and SCALED2P, that allow the user to rank behavioral anchors on the 7-point scale using either the keyboard or the game paddles. If the user is not familiar with the anchor, or feels that it does not apply to the task, then the "SKIP" selection can be made. In this case, no score is recorded. These programs are accessed through the MENU option 5, Develop Scale Anchor Points.

The data stored by the two scale development programs are accessed through MENU option 6, Review Anchor Point Data. MENU "RUNS" program RSC. You

will be required to enter the scale number and the task number; RSC then displays the emulated data to date in the format shown in Figure 3. The scale and task numbers can be determined from Appendices B and C. Enter scale number 1002 and task number 1 to see the current data for this anchor point. To quit this program, hit the return key twice.

FILE STRUCTURE OVERVIEW

The User's Disc is reserved for system programs and user response data files. Quit the MENU (hit key 7) and type CATALOG (return). All of the programs are locked as indicated by an asterisk in the right hand margin. In order to protect the programs from accidental overwriting, we have locked them. Since the User's Disc is used to store response data, it is not write-protected. Unlocked entries beginning with a T are text files containing user response data. Text files with personal names are job assessment response data files.

Put Disc A into disc drive 2 and type CATALOG, D2 (return). This disc contains text file names DATA nnnn, each of these files is a "page" from the Job Assessment program. These text files are shown graphically in Appendix B. There are two flow charts in Appendix B: one for mechanic job assessment and one for helicopter crewman job assessment. Each block in the flow chart represents a text data file. The number in the block, nnnn, corresponds to the number in the text file name, DATA nnnn. These files can be created or edited using the WRITE or FWRITE programs on the disc. Repeatedly press the space bar until the cursor returns, replace Disc A with Disc B and type CATALOG, D2 again. Press the space bar until the cursor returns. You will see files named SC nnnn. These are the scale rating files that contain the information used by the anchor point scale rating program: the aptitude definition and a series of example tasks (5 to 12) that the user is asked to rate as aptitude anchor points. These example tasks are listed in Appendix C for both the mechanic and the mechanized infantryman. These files can be created and edited using the SWRITE program on this disc. See Appendix A of this guide for instruction on the use of WRITE, FWRITE, AND SWRITE.

XXXX XX XXX / XXXX XX XXX / XXXX XX XXX / XXXX XX XXX /

SCALE #	TASK #	# OF SUBJECTS	Σx	$(\Sigma x)^2$	Σx^2
------------	-----------	------------------	------------	----------------	--------------

XXX

OF SKIP
RESPONSES

NOTE: x represents the anchor
point scale

FIGURE 3: SCATA XXXX PROGRAM DATA COLLECTION FORMAT

USER REFERENCE SHEET

MENU: Enter the number of the desired selection, i.e., "7" to quit.

(1) JOB ASSESSMENT:

- Answer all questions with a "Y" or "N."
- Type "Q" to quit.
- Type "B" to backspace and review.
- GAME PADDLE:
 - Turn pot to move cursor.
 - Push the button to store your response.
- KEYBOARD:
 - Type "U" to move the cursor up; type "D" to move the cursor down; and press "RETURN" to indicate your response.

(2) JOB ASSESSMENT REVIEW (BY RATER):

- Press space bar to review all ratings.
- Type "Q" to quit.

(3) REVISE JOB ASSESSMENT:

- Press space bar to review all ratings.
- Type "U" to move the cursor up.

- Type "D" to move the cursor down.
- Press "RETURN" to indicate selection of rating to be revised.
- Type "Q" to quit.

(4) JOB ASSESSMENT REVIEW (TALLY):

- Press space bar to review all ratings.
- Type "S" to review rating statistics.
- Type "Q" to quit.

(5) SCALE ANCHOR POINT DEVELOPMENT:

- Type "Q" to quit when skill description is on screen.
- Type "B" to backspace to skill description.
- GAME PADDLE:
 - Turn pot to move arrow cursor.
 - Push the button to store your response.
- KEYBOARD:
 - Type "U" to move the cursor up; type "D" to move the cursor down; and press "RETURN" to record your response.

(6) ANCHOR POINT DATA REVIEW:

- Enter 4 digit scale number and press "return" key.

- Enter task number and press "return" key.
- For different task on same scale, enter task number and press "return" key.
- For different scale, press "return" key (without entering task number) and then enter new scale number.
- To quit, press "return" without entering new scale number.

APPENDICES

APPENDIX A: USE OF PROGRAMS WRITE, SWRITE, AND FWRITE

APPENDIX B: JOB ASSESSMENT FLOWCHARTS

- **MECHANIC JOB ASSESSMENT FLOWCHART**
- **HELICOPTER CREWMAN ASSESSMENT FLOWCHART**

APPENDIX C: ANCHOR POINT TASKS

- **MECHANIC ANCHOR POINT TASKS**
- **MECHANIZED INFANTRYMAN ANCHOR
POINT TASKS**

APPENDIX A ·

**USE OF PROGRAMS WRITE,
SWRITE, AND FWRITE**

USING THE WRITE PROGRAM

TO WRITE A NEW TEXT FILE:

1. Type and
 <Return>

Program will RUN and print out a short explanation at the top of the screen, then BEEP, and print "BREAK IN 1."

2. Type in Data Statements (starting with line 100) in the following format:

100 Data "...".

- 2.1 If you are typing a TRANSACTION BLOCK (yes/no response) the entire text will be in line 100.

- 2.2 If you are typing a SCALE DATA BLOCK, type Data line in the following order:

100 Data "...High Amount. ..."
105 Data "...Moderate Amount..."
110 Data "...Some. ..."
115 Data "...Very Little. ..."
120 Data "...Scale Title. ..."

3. Type and <Return>

Screen will clear and then ask for the filename.

4. Type Filename and
 <Return>

Filename prints out at top of screen and question prints out "EDIT ONLY?"

5. Type and <Return>

Asks a series of questions about block number, position, and type.

6. Respond to questions and <Return>

Screen clears when the Text File has been written.

USING THE WRITE PROGRAM

TO EDIT AN EXISTING TEXT FILE:

1. Type and
 <Return>
 Program runs and prints out a short explanation at the top of the screen, then BEEPS, and prints "BREAK IN 1."
2. Type and
 <Return>
 Series of cursors will scroll up on screen and may BEEP and print out "UNDEF'D STATEMENT ERROR IN 350" Pay no attention to this error message.
3. Type and <Return>
 The screen will show the WRITE Program (up to line 90) and the TEXT FILE (from line 100 on).
4. Edit the Text File Lines as necessary
5. Type and <Return> to make final check
6. Type and <Return>
 The screen will clear and then ask for the Filename.
7. Type in Filename (new one if you wish or the old name)
 and <Return>
 Filename prints out at top of screen and asks "EDIT ONLY?"
8. Type and <Return>
 Asks if the block follows a scale data block.
9. Answer question and <return>
 Screen clears when the Text File has been edited.

USING THE FWRITE PROGRAM

TO WRITE A NEW TEXT FILE:

1. Type and Program will RUN and print out a short explanation at the top of the screen, then BEEP, and print "BREAK IN 1."
2. Type in Data Statements (starting with line 100) in the following format:

100 Data "..."

2.1 If you are typing a TRANSACTION BLOCK (yes/no response) the entire text of the statement will be in line 100.

2.2 If you are typing a SCALE DATA BLOCK, type Data lines in the following order (where x.xx is the task score from 0 to 7)

100 Data "x.xx..." (task with highest score)

105 Data "x.xx..." (task with lowest score)

110 Data "xx.xx..." (if there are 3 tasks)

115 Data "...Scale Title..."
3. Type and Screen will clear and then ask for the filename.
4. Type the data block number and Filename prints out at top of screen and question prints out "EDIT ONLY?"
5. Type and Asks a series of questions about block number, position, type.
6. Respond to questions and Screen clears when the TEXT FILE has been written.

USING THE FWRITE PROGRAM

TO EDIT AN EXISTING TEXT FILE:

1. Type and
 <Return>
Program runs and prints out a short explanation at the top of the screen then BEEPS, and prints "BREAK IN 1."
2. Type and
 <Return>
Series of cursors will scroll up on screen and may BEEP and print out "UNDEF'D STATEMENT ERROR IN 350." Pay no attention to this error message.
3. Type and <Return>
The screen will show the FWRITE Program (up to line 90) and the TEXT FILE (from line 100 on).
4. Edit the Text File Lines as necessary
5. Type and <Return> to make final check
6. Type and <Return>
The screen will clear and then ask for the Filename.
7. Type in block number
 (new one if you wish or the old number) and
 <Return>
Filename prints out at top of screen and asks "EDIT ONLY?"
8. Type and <Return>
Asks if the block follows a Scale Data Block.
9. Answer question and <return>
Screen clears when the Text File has been edited.

USING THE SWRITE PROGRAM

TO WRITE A NEW TEXT FILE:

1. Type **RUN SWRITE** and **<Return>**

Program will RUN and print out a short explanation at the top of the screen, then BEEP, and print "BREAK IN 1."

2. Type in Data Statements (starting with line 100) in the following format:

100 Data "...SCALE TITLE..."

105 Data "...SCALE EXPLANATION..."

110 Data "...TASK 1 STATEMENT...",
"...TASK 2 STATEMENT..."

199 Data "...TASK N STATEMENT..."

Note: If the computer beeps in the middle of the Scale Explanation, this means that there too many letters in the line. Shorten the explanation to fit within the line. If the computer beeps in the middle of a task statement, erase the portion started and start over on the next line.

3. If this is the first scale, then type an additional line: 90 REM

Screen will clear and then ask for the scale number.

4. Type **GOTO 2** and **<Return>**

Filename prints out a top of screen and question prints out "EDIT ONLY?"

5. Type Scale Number **....4 Digits....** and **<Return>**

Asks for the number of tasks and the next scale number.

6. Type **N** and **<Return>**

7. Respond to Questions and **<Return>**

Screen clears when the text files have been written.

USING THE SWRITE PROGRAM

TO EDIT AN EXISTING TEXT FILE:

1. Type and
 <Return>

Program runs and prints out a short explanation at the top of the screen, then BEEPS, and prints "BREAK IN 1."

2. Type and
 <Return>

Series of cursors will scroll up on screen, a BEEP sounds and then the screen goes back the way it was.

3. Type and <Return>

The screen will show the SWRITE Program (up to line 87) and the TEXT FILE (from line 100 on).

4. Edit the Text File Lines (lines 100 to 199) as necessary

5. Type and <Return> to
 make final check

6. Type and <Return>

The screen will clear and then ask for the Filename.

7. Type in Scale Number (new one if
 you wish or the old name)
 4 Digits.... and <Return>

Filename prints out at top of screen and asks "EDIT ONLY?"

8. Type and <Return>

Screen clears when the Text File has been edited.

APPENDIX B

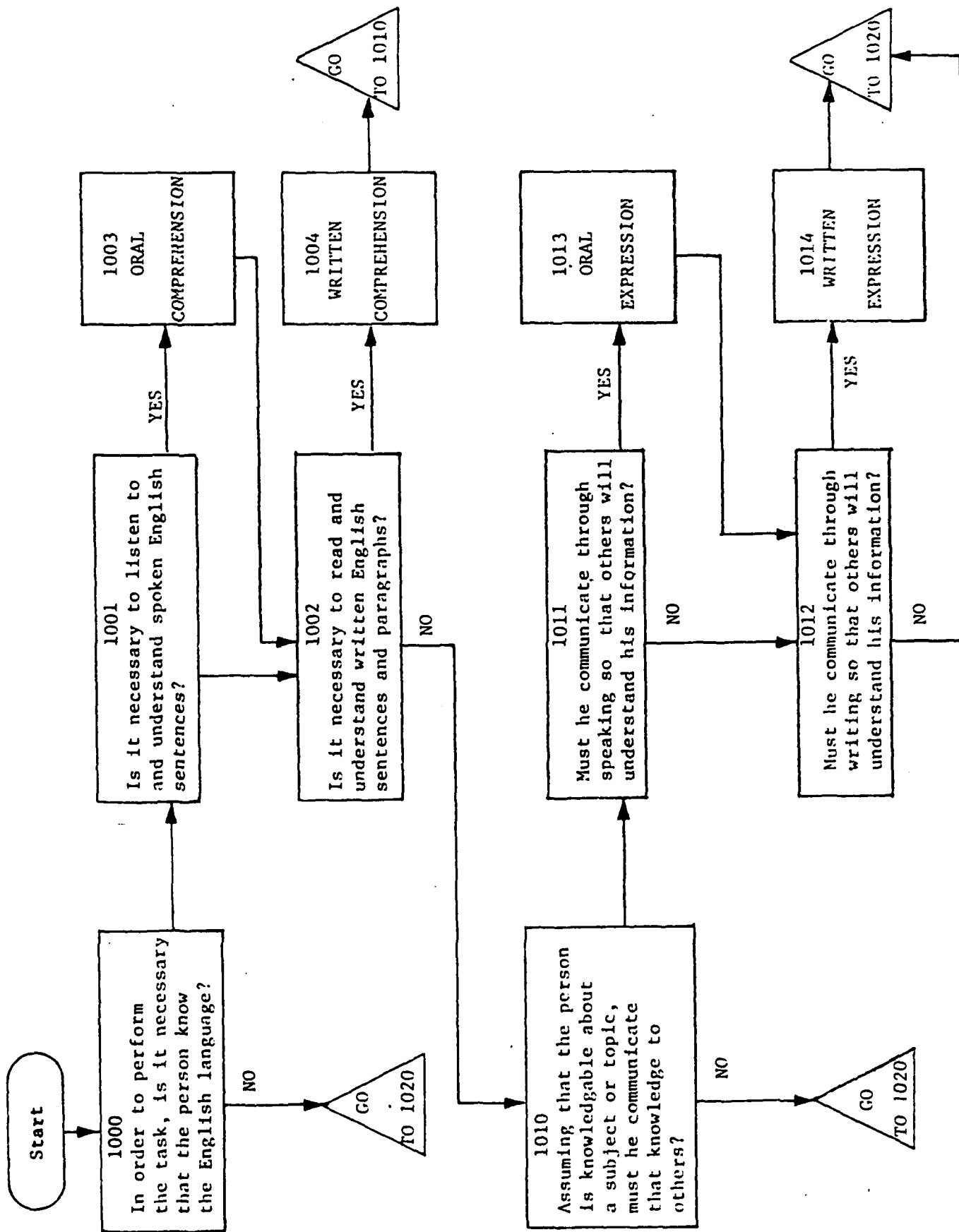
JOB ASSESSMENT FLOWCHART

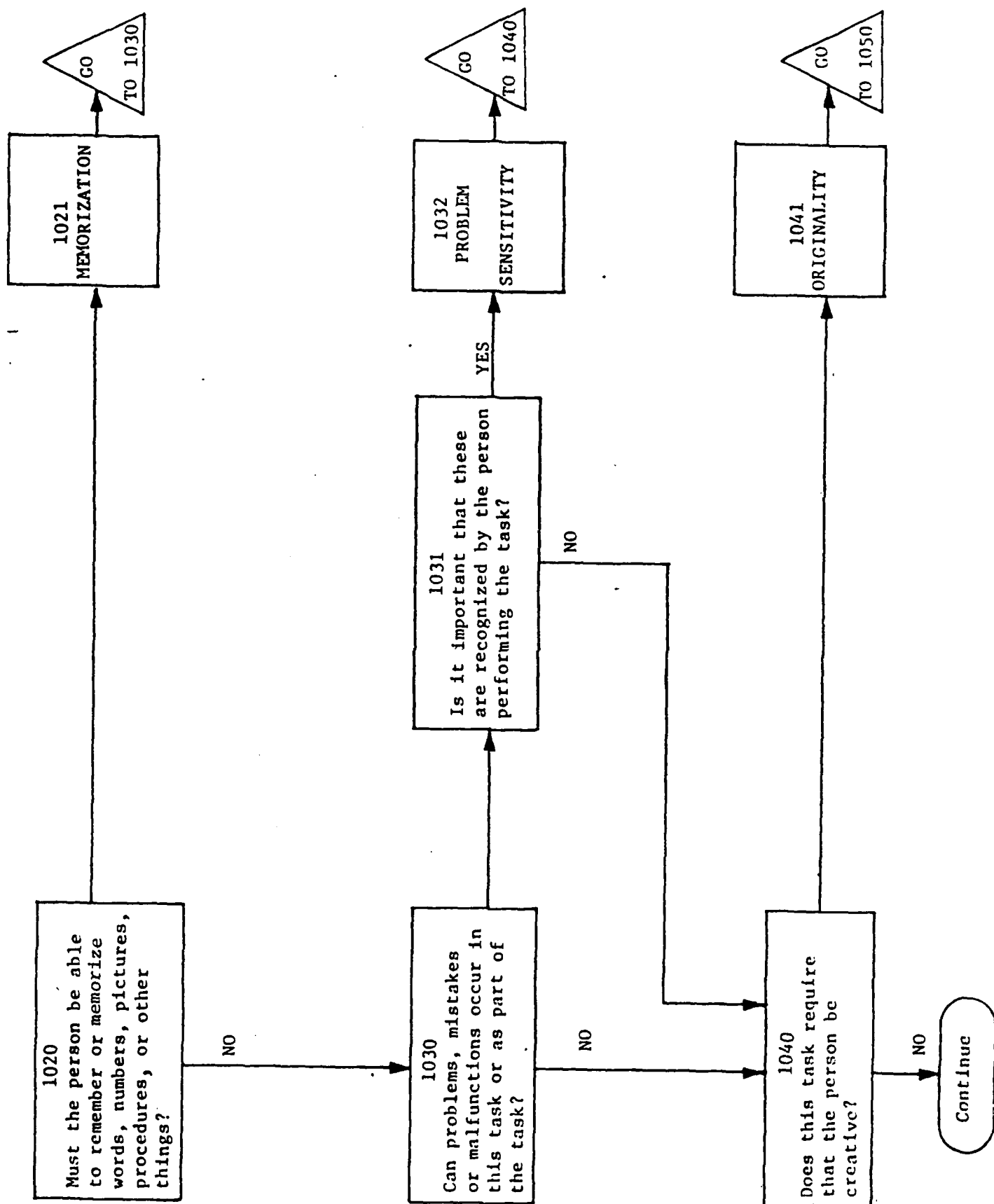
There are two branching network flowcharts in this appendix. One shows text data files for mechanic job assessment and the other shows the text data files for helicopter crewman job assessment. These text data files are found on Disc A. A separate text data file exists for each data block. They are titled DATA XXXX, where XXXX is the number at the top of each data block. Each text data file contains the full text that is shown on the screen plus flags for the next text data file.

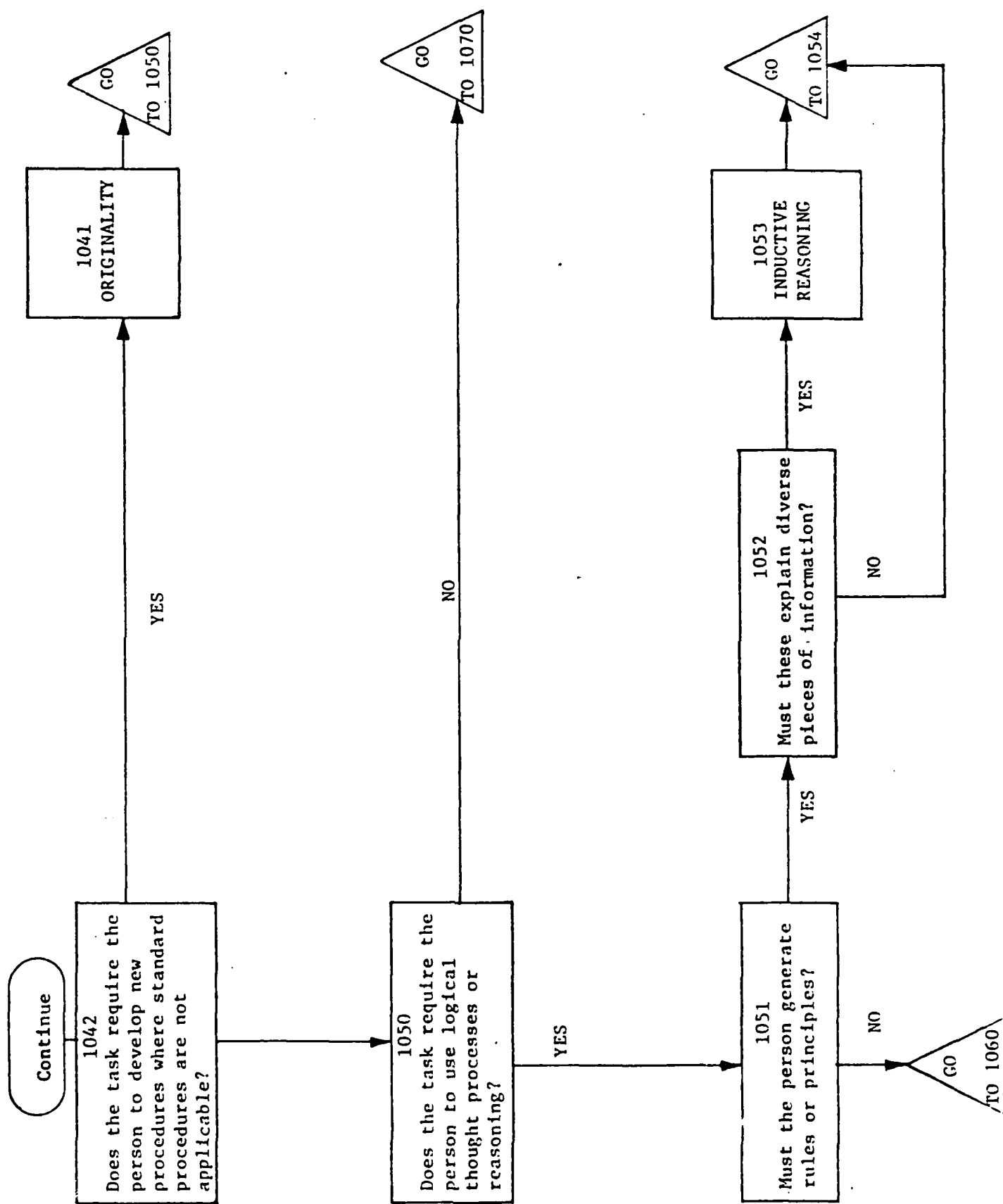
The branching network data files are shown here for three purposes.

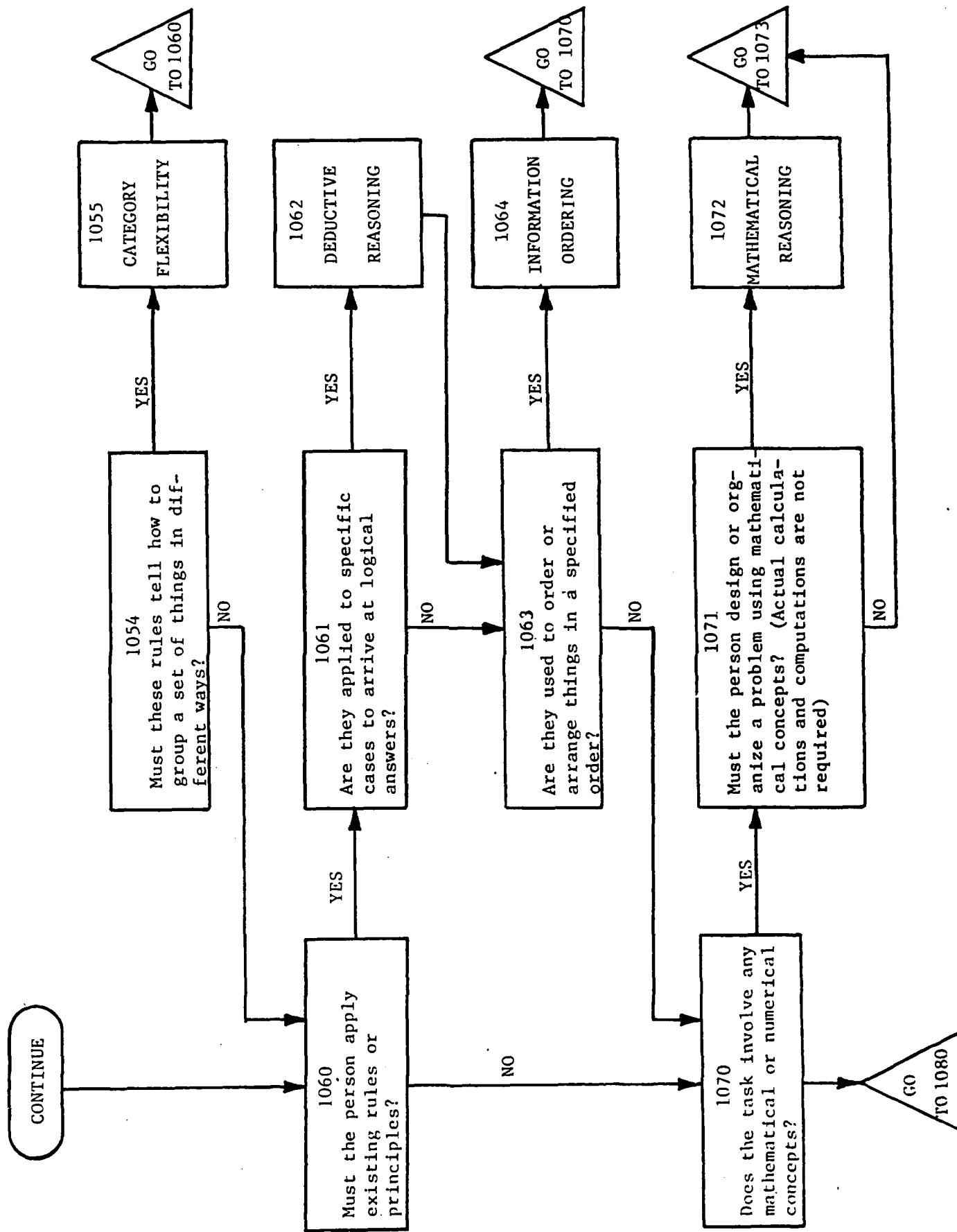
- Modifications can be made to the branching network using WRITE (for mechanic job) or FWRITE (for helicopter crewman) programs. The data block numbers are required to make these modifications.
- The scale data block numbers are required when analyzing the results of the anchor point development program (using RSC program).
- A knowledge of the branching network flowchart may be helpful when using the backspace feature in job assessment or the job assessment revision programs (FREV or REV).

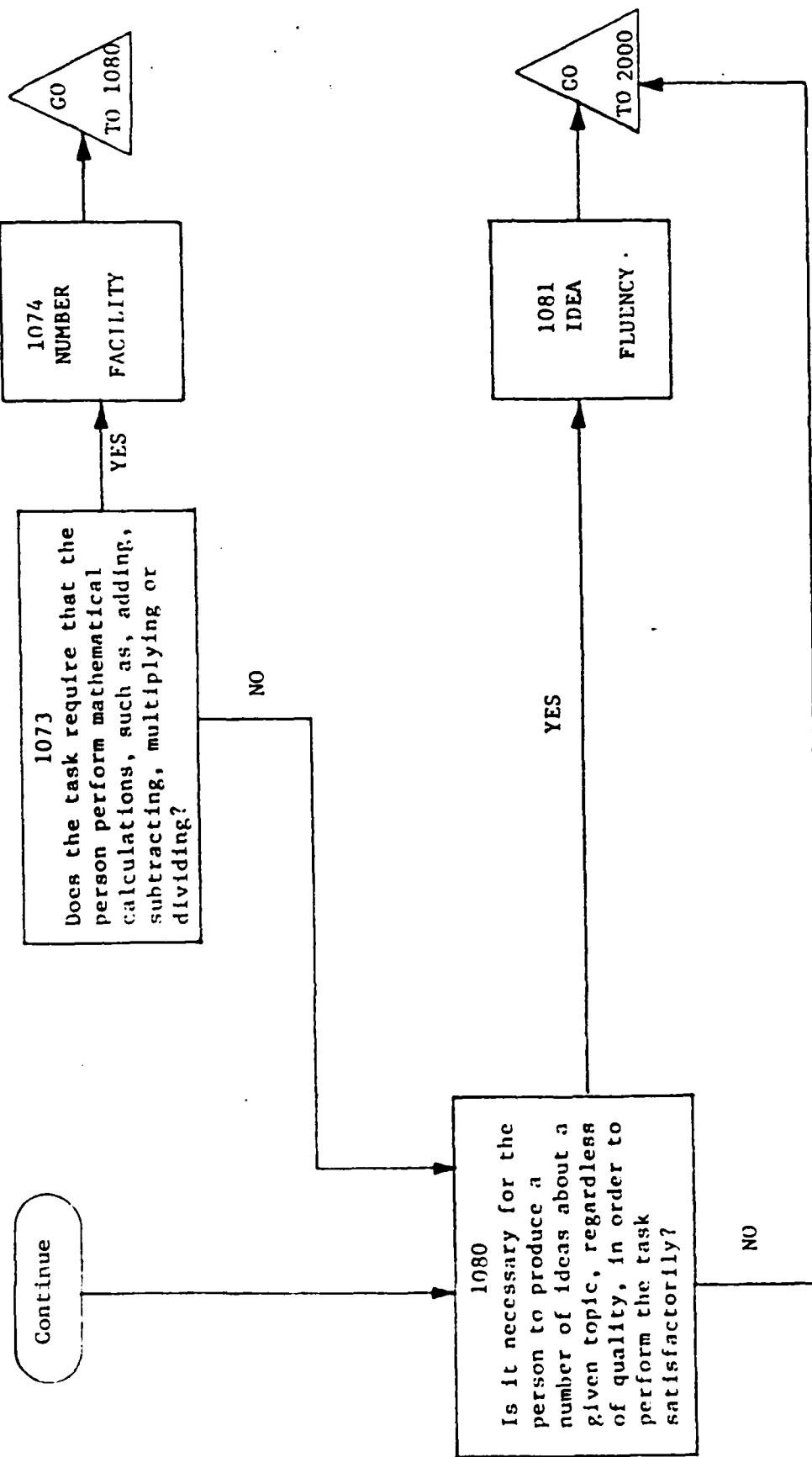
MECHANIC JOB ASSESSMENT FLOWCHART

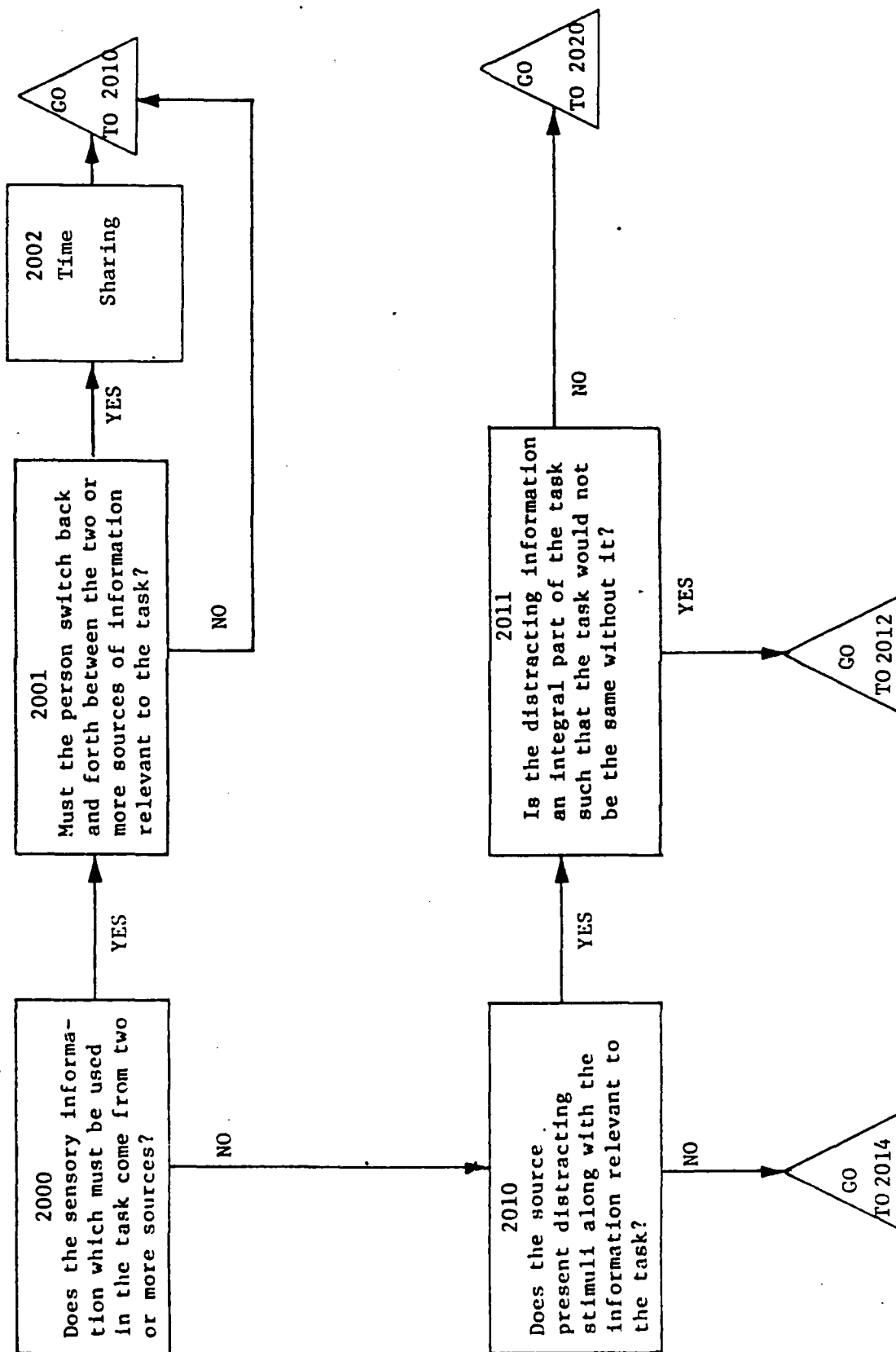


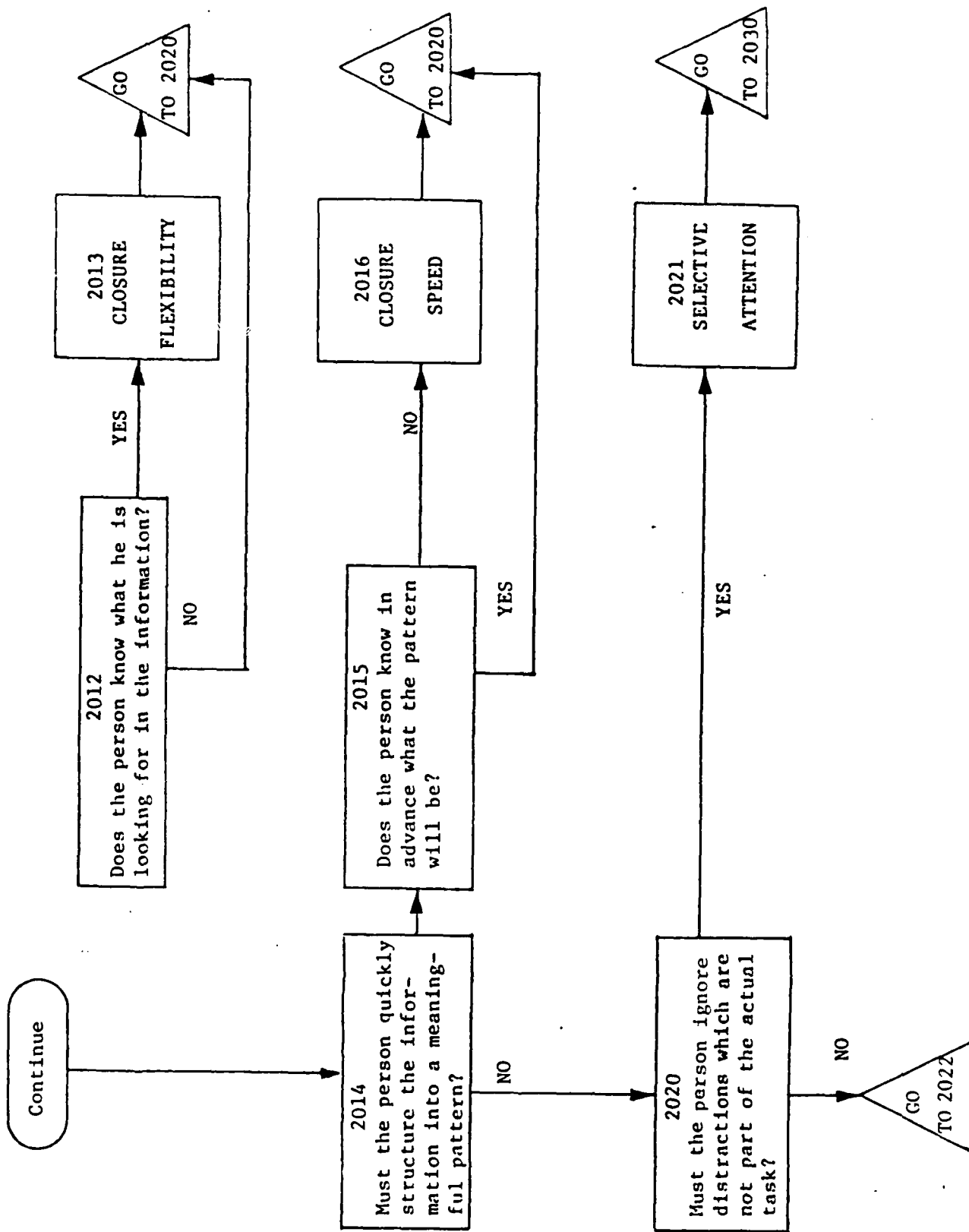


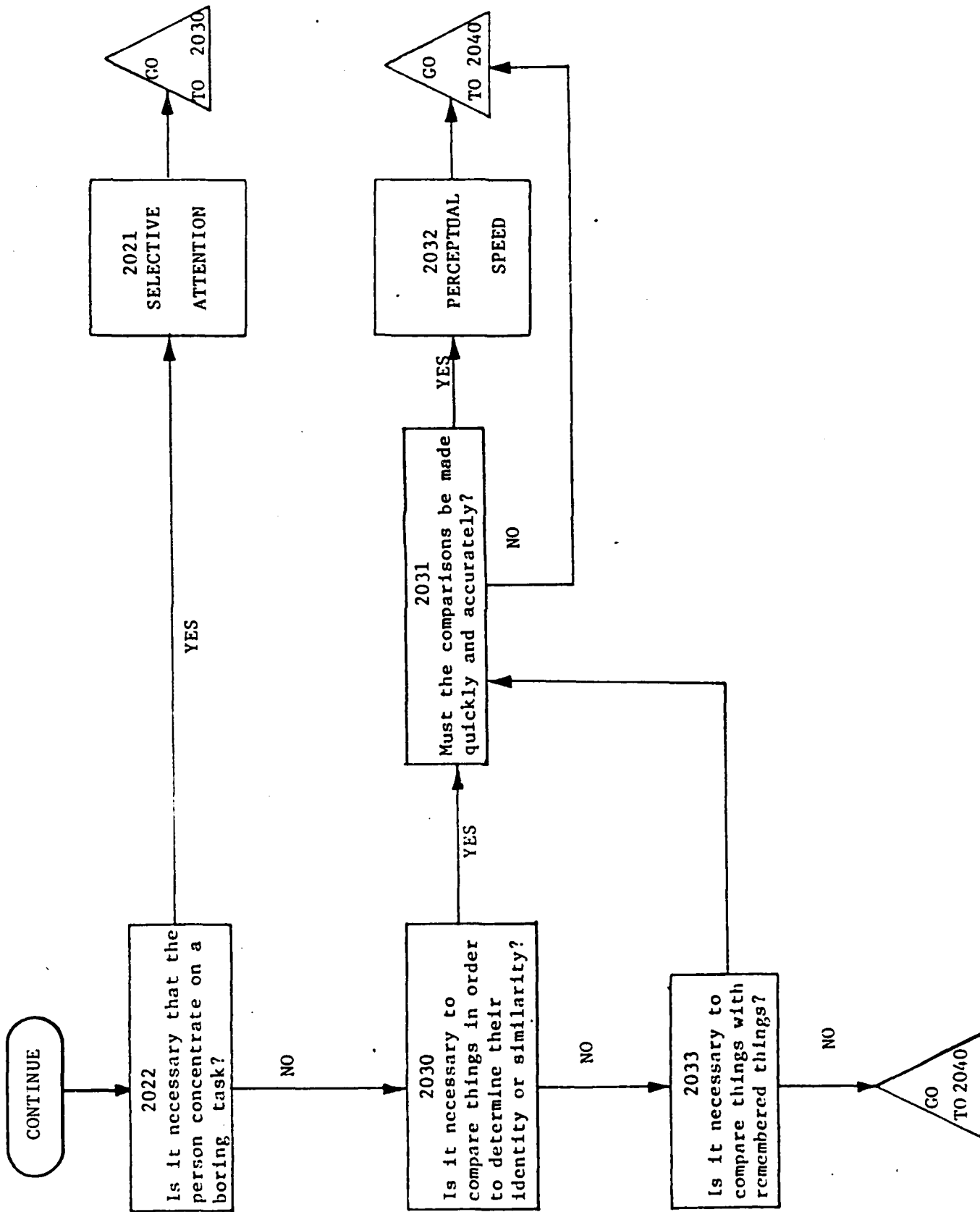


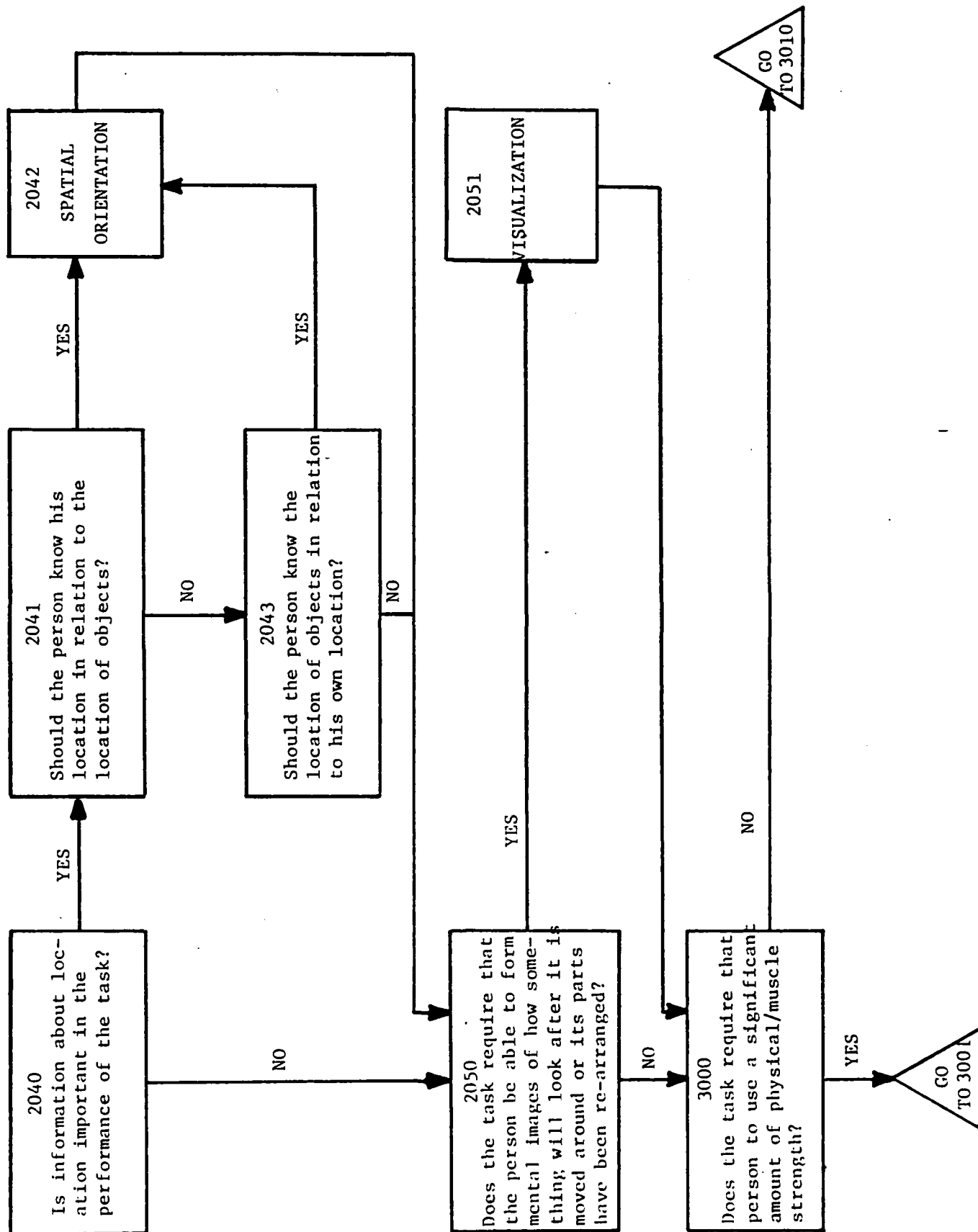


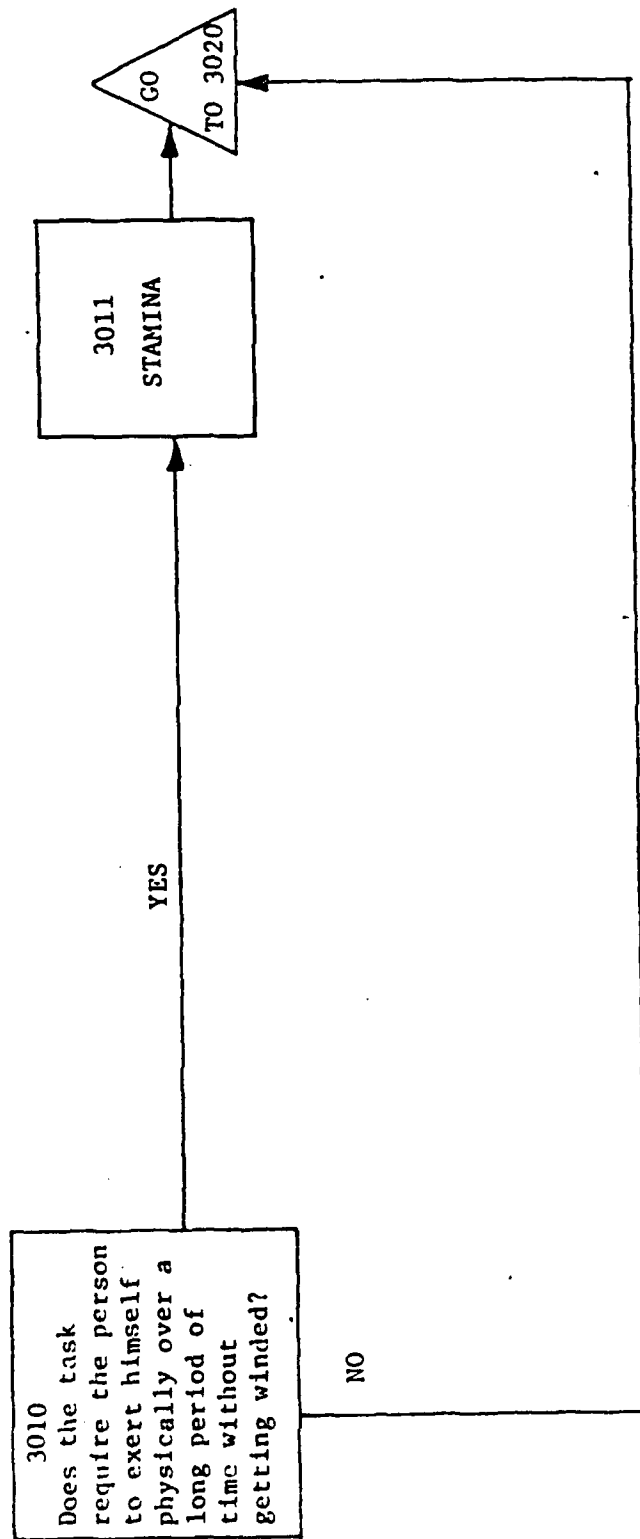


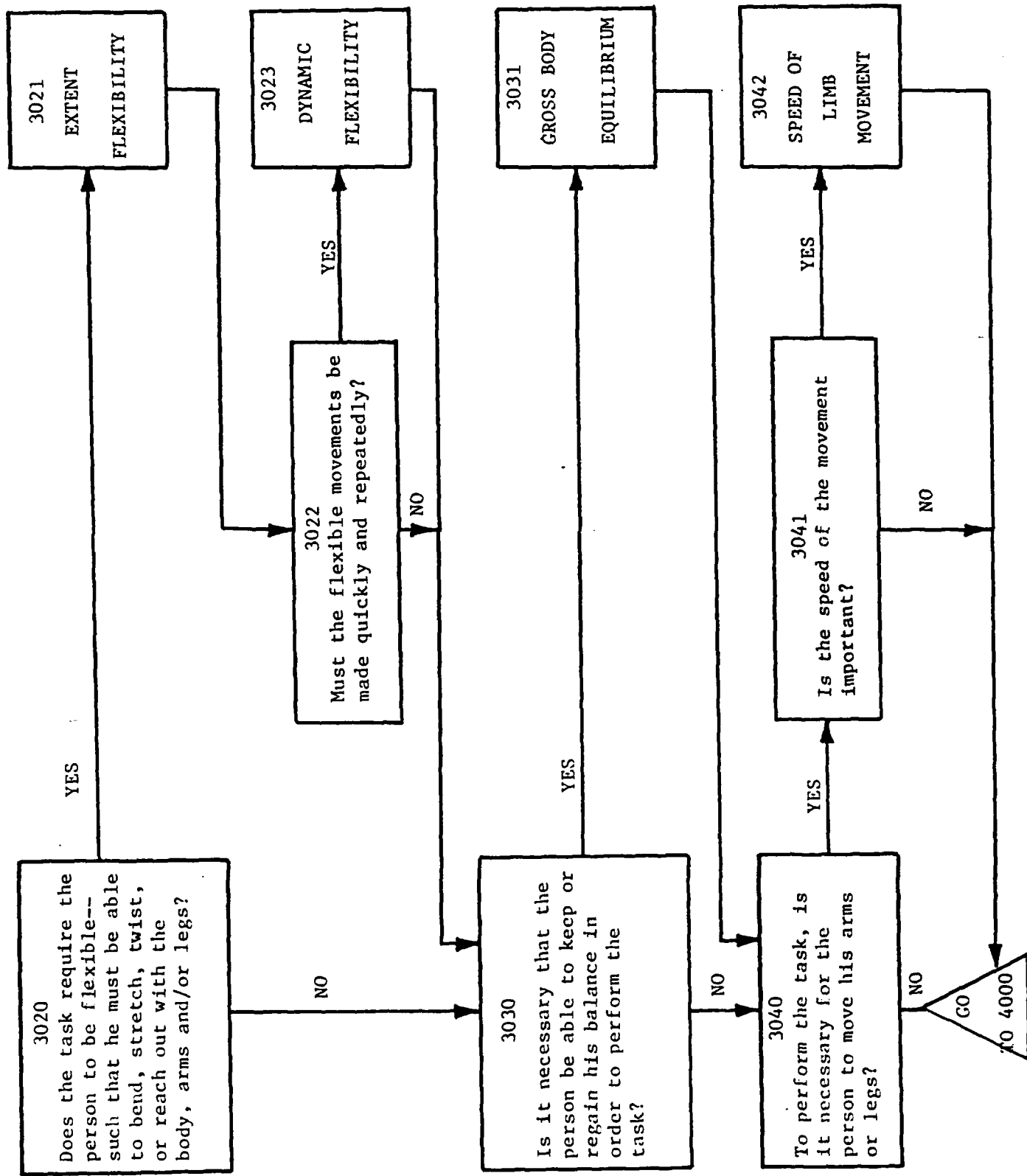


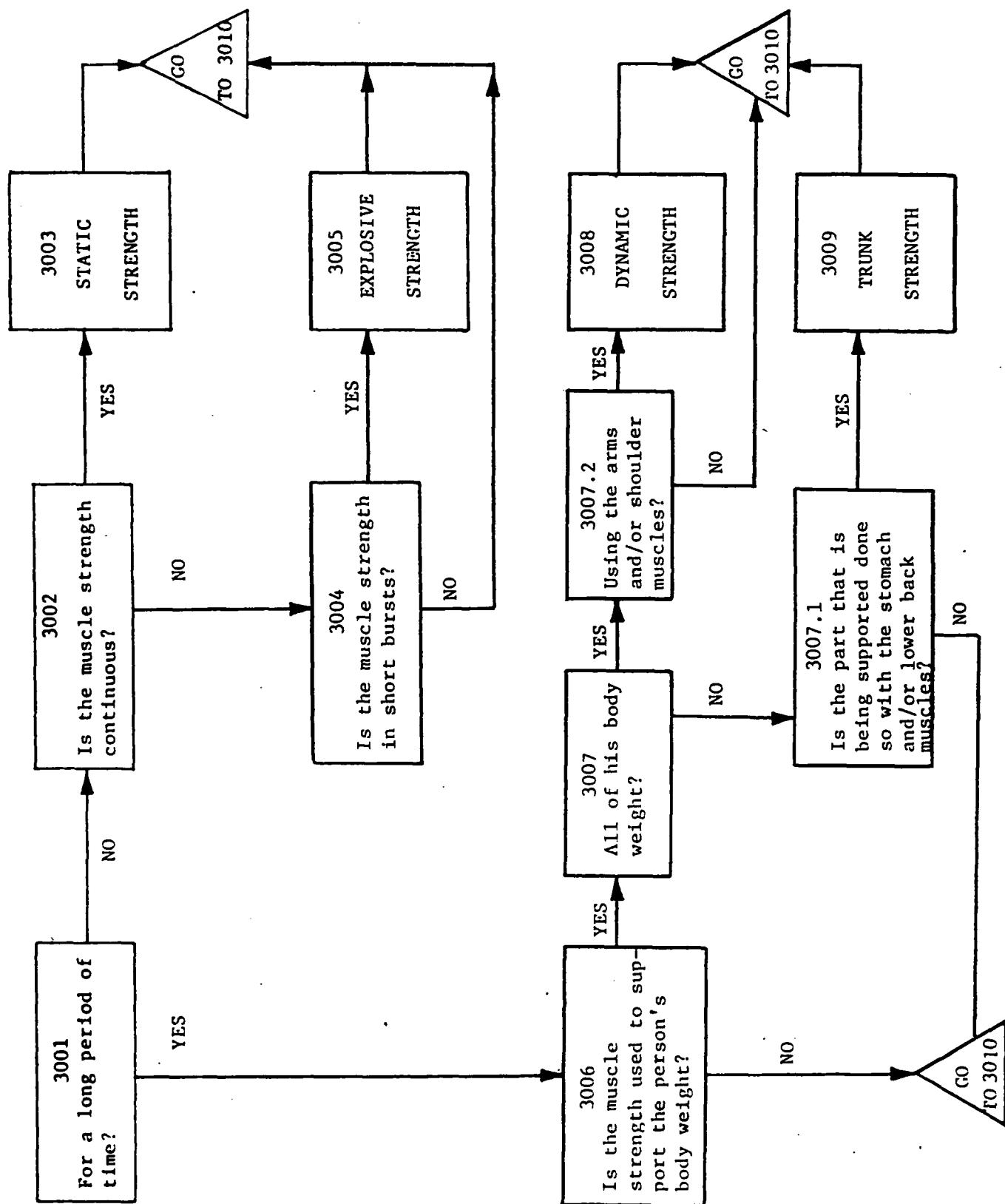


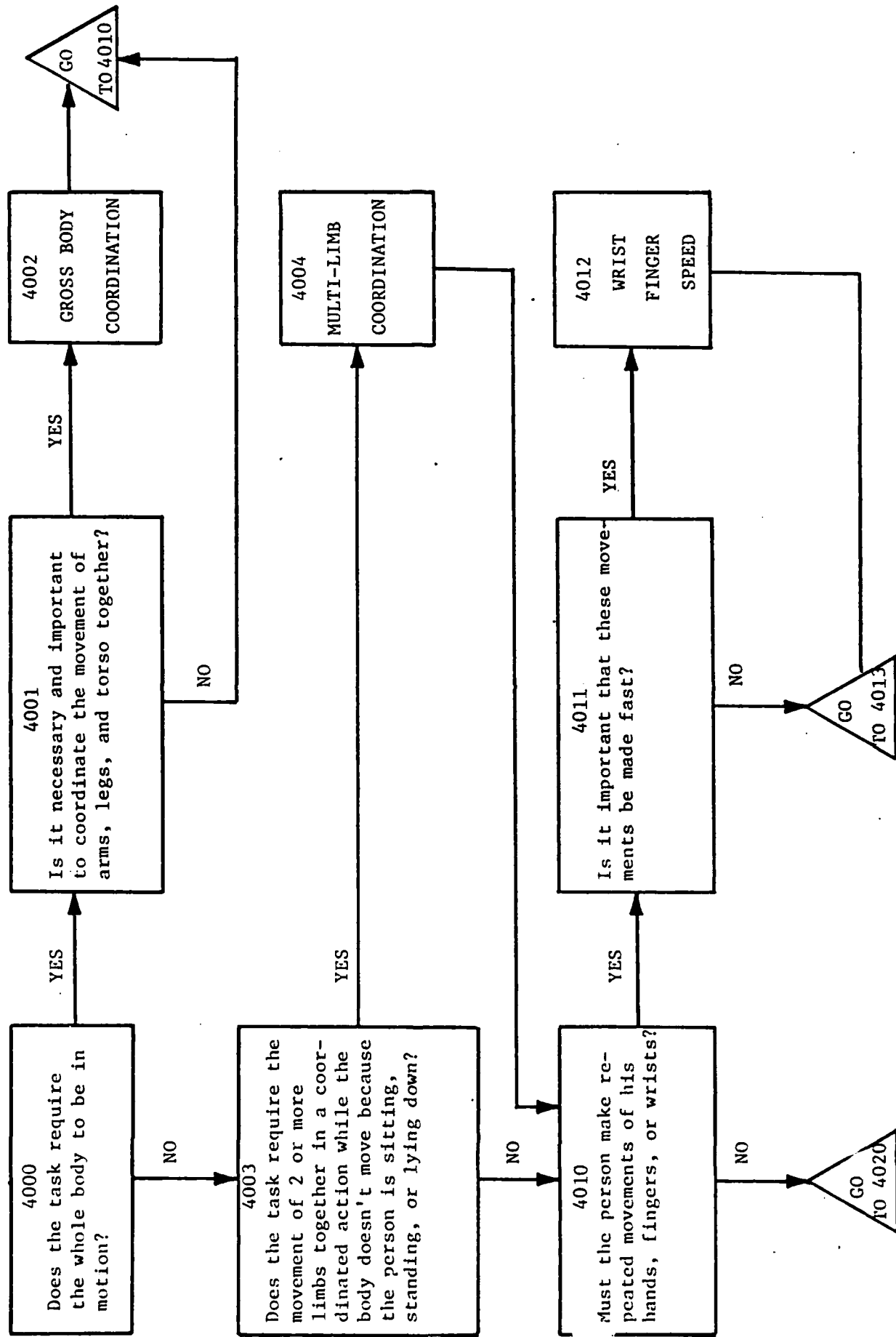


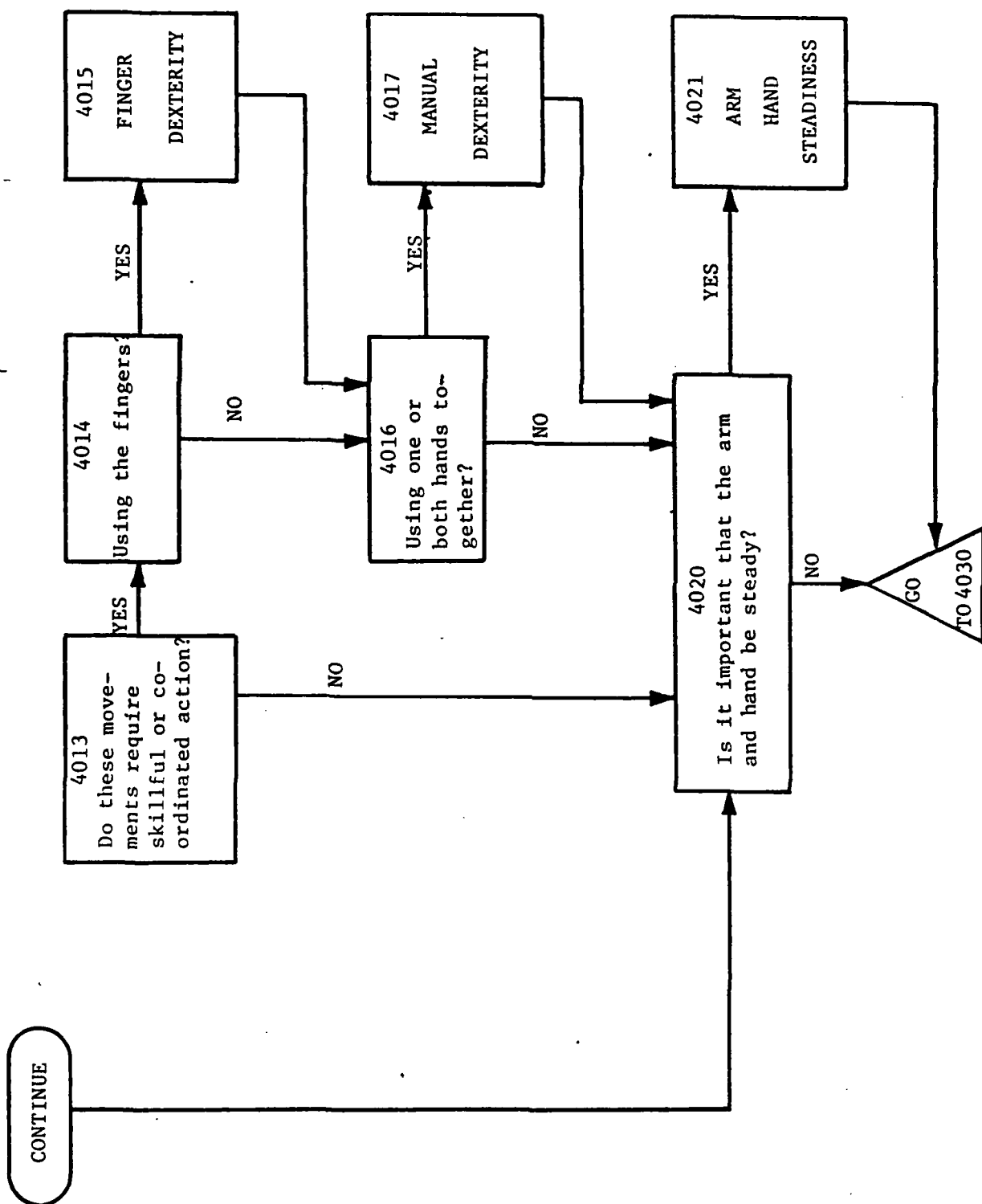


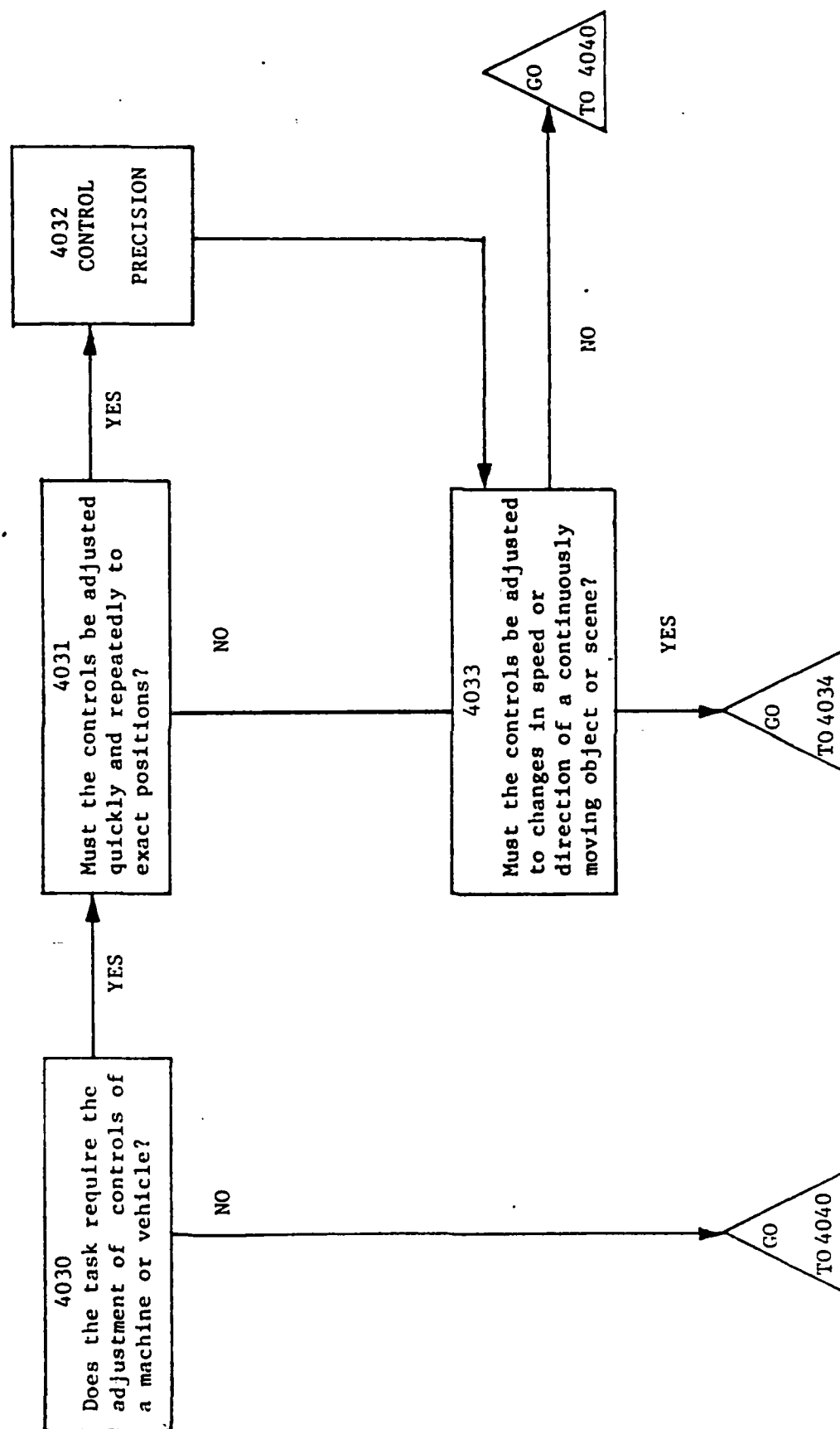


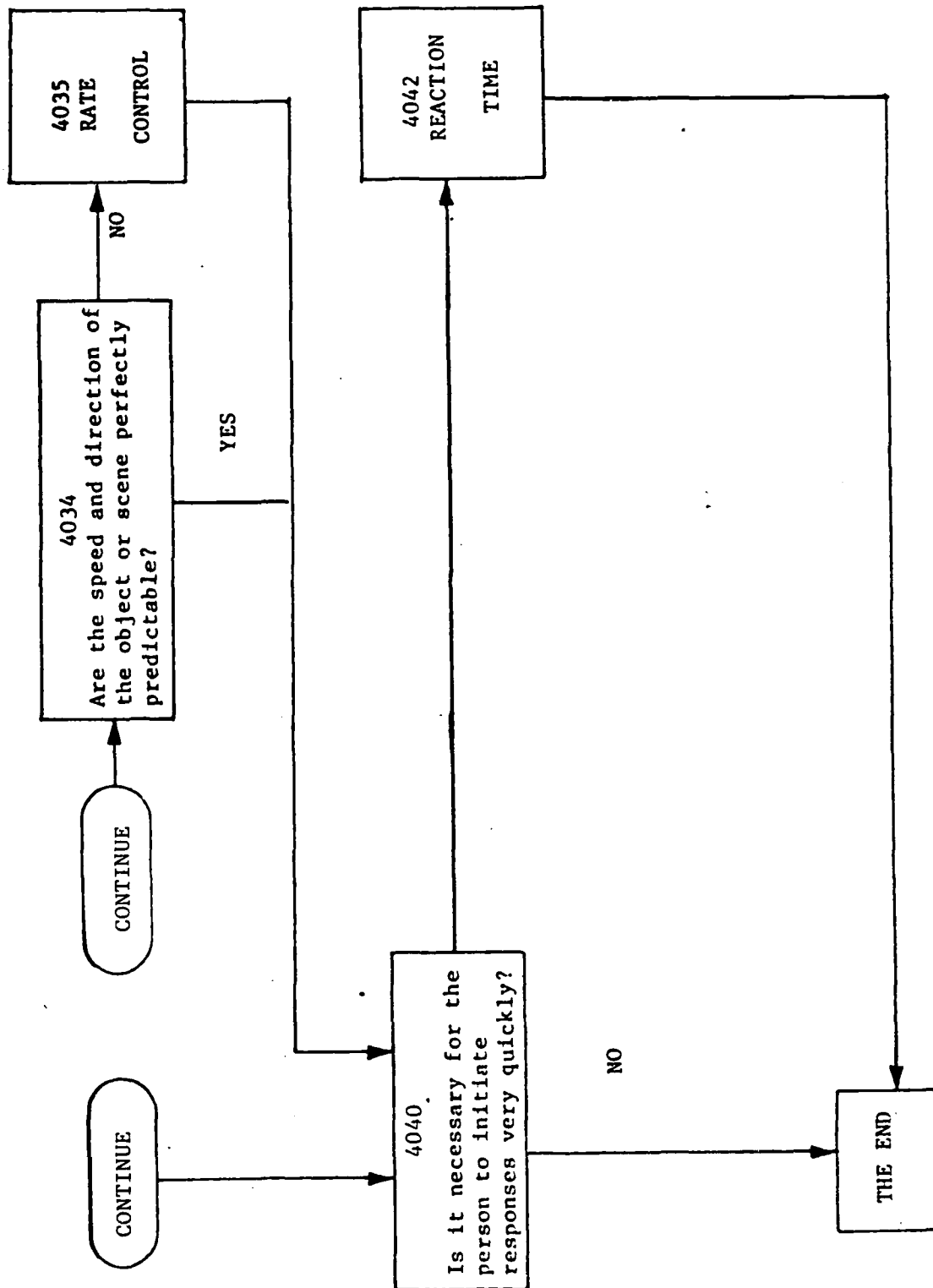












HELICOPTER CREWMAN ASSESSMENT FLOWCHART

